A. B. Kinzel
Union Carbide & Carbon Corp.
(See story, p. 18)

May, 1960

MR STACKS

METALS REVIEW

The News Digest Magazine

The 15th METALLOGRAPHIC EXHIBIT

Philadelphia, October 17 to 21, 1960

All metallographers—
everywhere—
are cordially invited to
display their best work.

RULES FOR ENTRANTS

Exhibitors do not need to be members of the American Society for Metals.

Work which has appeared in previous metallographic exhibits held by the American Society for Metals is unacceptable.

Photographic prints should be mounted on stiff cardboard, extending no more than 3 in. beyond edge of print in any direction; maximum dimensions 14 by 18 in. (35 by 45 cm.) Heavy, solid frames are unacceptable.

Entries should carry a label on the *face of the mount* giving:

Classification of entry.

Material, etchant, magnification and other desirable data.

A brief statement (if desired) calling attention to any unusual aspect of the entry.

The name, company affiliation and postal address of the exhibitor should be placed on the *back of the mount* together with a request for return of the exhibit if so desired.

Entrants living outside the United States should send their micros by first-class letter mail endorsed "Photo for Exhibition — No Commercial Value — May Be Opened for Customs Inspection".

Exhibits must be delivered before Oct. 1, 1960, either by prepaid express, registered parcel post or first-class letter mail, addressed:

Metallographic Exhibit
American Society for Metals
Metals Park
Novelty, Ohio, U. S. A.

CLASSIFICATION OF MICROS

Class 1. Irons and steels, cast and wrought
Class 2. Stainless steels and heat resisting alloys
Class 3. Aluminum, magnesium, beryllium, titanium and their alloys
Class 4. Copper, nickel, zinc, lead and their alloys
Class 5. Uranium, plutonium, thorium, zirconium and reactor fuel and control elements
Class 6. Metals and alloys not otherwise classified
Class 7. Series showing transitions or changes during processing
Class 8. Welds and other joining methods
Class 9. Surface coatings and surface phenomena
Class 10. Slags, inclusions, refractories, cermets and aggregates
Class 11. Electron micrographs using replicas
Class 12. Electron micrographs (transmission)
Class 13. Color prints in any of the above classes
Class 14. Results by unconventional technique

AWARDS AND OTHER INFORMATION

A committee of judges will be appointed by the Metal Congress management which will award a First Prize (a medal and blue ribbon) to the best in each classification. Honorable Mentions will also be awarded (with appropriate medals) to other photographs which in the opinion of the judges closely approach the winner in excellence. A Grand Prize, in the form of an engrossed certificate and a money award of $500 from the Adolph I. Buehler Endowment will also be awarded the exhibitor whose work is judged best in the show, and his exhibit shall become the property of the American Society for Metals for preservation and display in the Society's national headquarters.

All prize-winning photographs will be retained by the Society for one year and placed in a traveling exhibit to the various Chapters.

42nd NATIONAL METAL CONGRESS & EXPOSITION

Philadelphia Trade & Convention Center——————Oct. 17 to 21, 1960

May, 1960 Vol. XXXIII, No. 5

METALS REVIEW

The News Digest Magazine

T. C. DuMond
Editor

Betty A. Bryan
Associate Editor

James C. Nelson
Associate Editor

A. P. Ford
Sales Manager

William J. Hilty
Advertising Manager

G. H. Loughner
Production Manager

ADVERTISING OFFICES

Rodney W. Cramer
Metals Park, Novelty, Ohio
JOrdan 4-2271

John B. Verrier, Jr.
Fred Stanley
342 Madison Ave., Room 1228
New York 17, N.Y.
OXford 7-2667

Donald J. Walter
53 W. Jackson Blvd.
Chicago 4, Ill.
WAbash 2-7822
and
20050 Livernois St.
Detroit 21, Mich.
UNiversity 4-3861

William F. Mills
(Whaley-Simpson Co.)
6608 Selma Ave.
Los Angeles 28, Calif.
HOllywood 3-7157

Gordon Simpson
(Whaley-Simpson Co.)
700 Montgomery St.
San Francisco 11, Calif.
SUtter 1-4583

Published monthly at 404 N. Wesley Ave., Mount Morris, Ill., by the American Society for Metals. Editorial and general offices Metals Park, Novelty, Ohio: Walter Crafts, President; W. A. Pennington, Vice-President; R. J. Raudebaugh, Treasurer; W. E. Jominy, Secretary; Earl Parker, M. A. Scheil, C. H. Samans and A. R. Fairchild, Trustees; C. H. Lorig, Past President. Subscriptions, $6.00 per year ($7.50 foreign). Single copies $1.50. Second class postage paid at Mount Morris, Illinois.

Claims for missing numbers will not be allowed if received more than 60 days from date of issue. No claims allowed from subscribers from overseas, or because of failure to notify the circulation department of a change of address or because copy is "missing from files".

Contents

Steel Leader Discusses Impact of Foreign Steels on U.S. 4
A.S.M. Chapter Organizes Boy Scout Explorer Post 6
Toolsteel Book Announced 7
Augustus B. Kinzel to Head Technical Council 18
1960 Seminar—Strengthening Mechanisms in Solids 21
Early Exhibitors in Philadelphia Metal Show 22

Important Lectures

Slip Casting Metal Powders, by P. D. S. St. Pierre 7
Bomarc Missile System, by John F. Baish 9
Magnetic Particle Inspection, by John H. Heller 10
Bonding Dissimilar Metals, by Paul R. Chandler 10
Electron Beam Welding, by A. Lesnewich 12
Natural Media Corrosion, by C. P. Larrabee 12
Research in the Materials Field, by Frank L. LaQue 13
Explosive Working of Metals, by John Pearson 14
Engineering Properties of Carbonitrided Cases, by K. B. Valentine 14
Patents and the Modern Engineer, by J. G. Jackson 15
Creep and Deformation of Metals, by Earl Parker 17
Modern Plastics, by K. F. Charter 17
Electron Beam Welding, by W. Farrell 19
Behavior of Gases in Steelmaking, by T. F. Kearney 21
Submerged Arc Welding Techniques, by W. B. Sharav 22

Departments

Metallurgical News 8
Employment Service Bureau 23

Steel Leader Discusses Impact of Foreign Steels on U.S.

IF YOU SHARE MY CONCEPT—THAT THE MAJOR task of any business management is to perpetuate their company—these facts will be of interest to you. They bear directly on your ability to survive in the decade of the 70's.

As steel consumers you have discovered that during the past year or so, certain of the steel mill products have been made available to you from such far away places as Germany, Belgium, Luxembourg and Japan. In 1958 and early 1959, prices for these imports sometimes ran $20 or so under the domestic delivered cost.

"In 1959 imports exceeded exports in steel for the first time in this generation", F. R. Widmer, Republic Steel Corp., told members of the Rockford Chapter, at a recent meeting. "While it is true that the last half of 1959 saw a sharp increase in the price of imports and availability generally diminished, you still can't talk away the facts. There must be a sharp change in the balance of supply and demand between the U. S. and the rest of the free world. Physical facilities and technical capabilities are now available that did not exist previously".

But—they hit seven million in '55—this year their expectations should be close to eight million—considering the high levels of personal income.

The extra million cars that won't be built in 1960 worms its way back through the American economy leaving a *black smudge* on your nose and mine. It's time we crossed our eyes and took note.

Imported steels are only one indication of the competition facing the United States economy, according to the speaker. He cited growing imports of automobiles, toys, typewriters, radios and televisions, all of which threaten the marginal producer of these products. Imports fall into several well-defined categories, Mr. Widmer pointed out.

Foreign producers forced to rebuild in the postwar period were able to adopt American standards and mass production methods. In addition, the idea of mass markets to match mass production techniques has finally been understood and has been put into operation by our foreign competitors.

In addition, it appears that the long-cherished dream of the free traders of one economic world is at least starting to emerge.

In facing this new competition the steel industry has had to consider the degree of vulnerability to foreign invasion that is inherent in the products it makes.

"First and most dangerous are those where the exporting company has looked over our market and picked a product area where they can use all of their best economic advantages. They then design a product, establish a permanent sales and marketing organization, set up a mass production plant and let go with both barrels.

"The Japanese seem to have been most successful with this procedure. Any American company that has received that charge of shot is either dead or in a bad way. So far we have not found an effective, competitive strategy. In some products the Japs have captured so large a share of the market that they have backed off for fear of American governmental retaliation.

"The second most dangerous situation is a modification of the first. The product is one that is the same or only slightly modified from its foreign counterpart. In the steel industry, nails, farm fence and barb wire are examples. Here in Rockford you would class fasteners and building hardware in this group.

"Your foreign competitor has a domestic market, a going engineering and production facility. He finds that he can lower his total costs by expanding his production facilities to give exports a *permanent* place in plans.

"This type of competitor can be a substantial irritation. He and others like him can knock the top off the American market, lower price levels, steal your best customer. Like your domestic competitor, he's always around making life difficult but if you on your toes, he doesn't put you out of business.

"However, in combination with one or more aggressive domestic competitors this can be the last straw for any company that is in the least way marginal to start with.

"The third type of foreign competitor is the least to be feared. This is the plant without a

market . . . the opportunists who offer products for sale through agents at whatever price they can get. They are in and out, depending upon demand for their products in the home market.

"In 1958 and '59 a great deal of the wire rods, reinforcing bars and steel pipe that was exported to the U. S. fell into this category. Right now, in steel, most of these sources are no longer available. The products are needed at home.

"First of all", Mr. Widmer continued, "most steel is a fabricating material. It must be forged, machined, stamped, welded or otherwise worked into a finished end item. Because the needs of fabricators are almost without limit in their variability, sheets, bars and plates come in almost countless variations as to size, grade and quality. Consumers are furnished a product that is tailored to their needs and has very little possibility of being adapted to another.

"Over the years the steel industry has extended its integration to pick up products *made from* steel mill products that lend themselves to our production processes. These include pipe, barb wire and nails.

"In the product group, requiring complex tailoring to each customer's requirements, we have been almost immune to imports.

"In the second group our markets have been invaded to a degree that is truly frightening.

"In between the two extremes there has been some invasion by wire rods and reinforcing bars. Here we have products that require further fabrication, yet the technical standards are simple, the deterioration in storage problems are negligible, the market large and easy to find.

"We have identified the producers of these imports and find that they fall into the number two and three groups mentioned earlier. In no case have we found a producer who has put in equipment for the sole purpose of invading our markets".

In evaluating the basic economic factors underlining the competitive abilities of our foreign invaders some facts are starting to emerge.

"There is no question about wage rates—they are low. However, this is offset in varying degrees by other factors. Usually our raw materials are better and cost less. Our productivity is higher—our integration is more complete and more efficient.

"Furthermore, the standard of living is increasing in the European and Japanese economy —wage rates are increasing. The cost advantage arising from low living standards will decrease year by year, *if we also make an all-out effort to increase our own productivity*".

Foreign competitors have been helped by the fact that in the years of the great depression of the 30's steel capacity fell behind the long-term growth trend of the economy. Steel was underpriced, we gave our capital away. There was little money available for modernization.

In the war years we made steel for guns and tanks and ships. We fell further behind. Price control became profit control—we came out of the war with a dilapidated plant and broke and faced the postwar boom demand that overwhelmed the whole economy.

"From 1947 to '57 the steel industry concentrated on production and increased capacity. While it is true that the new capacity is efficient and produces a relatively lower cost product, we were forced to hold in use a lot of equipment that was not. Under more normal conditions a larger share of new capital would have gone to replace obsolescent equipment.

"In 1959 and '60 we are proving our belief that there is plenty of steel capacity. In the middle of a boom period—and on top of the longest industry-wide strike in history—we are producing steel at a rate that will build ten million tons of inventory in the hands of our customers by mid-year.

"In Republic we recognized this fundamental shift in the balance between supply and demand some time ago—today our capital investment is directed toward efficiency and productivity rather than increased capacity. We have over $375 million being spent or earmarked. Whole mills that were considered "good enough" by the standards of the 40's and 50's will wind up as scrap.

"This is our number one answer to foreign competition—greater efficiency and productivity, lower costs—competitive prices.

Our number two answer is in research and development. A large part of our effort is directed toward new steelmaking processes which will work their way into the new plants and equipment we are going to build in the future. Effort is also going into the development of products that will increase the market for steel.

These new efforts on our part are impressive but they aren't enough—there is still more to this problem. Let's flip the coin. What's on the other side—the answer, of course, is EXPORTS.

We have skills, economic advantages, marketing knowledge in many areas that surpass those possessed by our foreign competitors. Yet only a few American corporations have made the effort to exploit these advantages.

In too many cases our exporting effort falls into that number three class of "the least to be feared" that I mentioned earlier.

We must awaken to the fact that as a nation every dollar that leaves America must be passed by a brother on the way home again.

We cannot expect government to juggle interest rates, tariffs and international agreements to achieve this. American industry must change its concepts and redirect a part of its efforts if we are to avoid a long-term unfavorable balance of trade.

A.S.M. Chapter Organizes Boy Scout Explorer Post

THE COLUMBIA BASIN CHAPTER, Richland, Wash., has sponsored a Boy Scout Explorer Post with the broad field of metallurgy as its specialty. This is believed to be the first Explorer unit backed by an A.S.M. chapter as well as the first metallurgy specialty post.

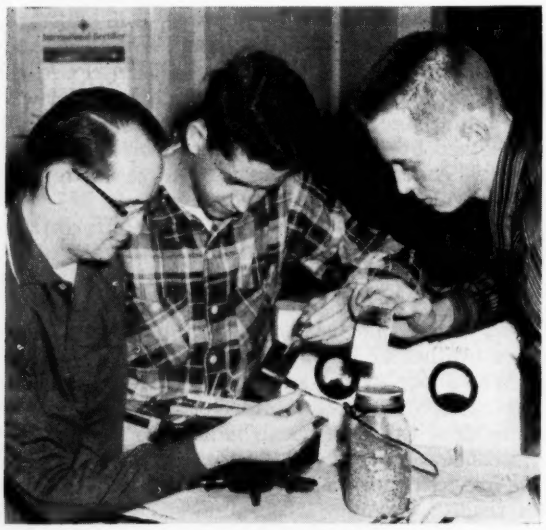
This sponsorship advances one of the major goals of the Chapter, which is to support youth activities and to interest young men and women in the field of metals.

Previous efforts have included support of the Mid-Columbia Science Fair, preparation of exhibits for local schools, presentation of honoraria to teachers who have made contributions in the fields of science, and awarding of scholarships to graduates of the local high schools. The Explorer Post represents a more sustained program and one requiring substantial participation by the A.S.M. Chapter members. They have wholeheartedly supported the new program; more than 50 members have volunteered to act as Post committee members, leaders or consultants to the boys.

The revised Explorer Scout program with its provision for a specialty set up by the sponsor permits the A.S.M. to reach young men in the 14-18 year age group, and to interest them in the physical sciences, particularly in the area dealing with metals. It is hoped that Post technical projects will help the scouts in later selection of their professions. The new Explorer program operates more like a teen-age club with its major interest in this case being metallurgy.

The Explorer Post has members working on a variety of projects. Specific projects set up by the consultants, who were selected on the basis of professional competence in the fields studied, include construction of a gas-fired melting furnace, casting of metals by lost wax and conventional sand mold processes, photo-engraving, extrusion, electroplating, metallography and extractive metallurgy, including reduction and refining of the metals. A special project will include the collection of an ore, its reduction to

Members of the Explorer Post Sponsored by the Columbia Basin Chapter Shown Working on Metalworking Experiment



Boy Scout Explorers Hard at Work on Metalworking Project. They are aided in this work by Columbia Basin members

the metal and subsequent conversion to some useful object by melting and casting.

The project in furnace making has been completed and work in melting and casting has been greatly simplified through the generosity of Oregon Brass Co., which donated most of the equipment and materials required. Another project, photo-engraving, is serving two purposes. The Explorer Scouts learn photo-engraving while assisting in a Columbia Basin Chapter service project, the awarding of a plaque to the best metallurgical exhibit in the Mid-Columbia Science Fair.

Excellent facilities are available—the Chief Joseph Junior High Shop is used, with the shop teacher, Jack Rees, acting as an associate advisor. John Burnham is the advisor and Edward A. Smith and Frank B. Quinlan are associate advisors. The Chairman of the Student Affairs Committee is automatically Institutional Representative and serves as the connecting link between Explorer Post and the Chapter.

A Special Metalworking Project Occupies the Attention of a Boy Scout Explorer

Slip Casting Metal Powders

THE PROCESS OF SLIP CASTING metal powders in relation to comparable techniques in the ceramic industry was discussed at Ottawa Valley by P. D. S. St. Pierre, metallurgy and ceramics research department, Research Laboratory, General Electric Co.

Slip casting is a forming method whereby powdered metal, suspended in an aqueous medium, is poured into an absorbent mold which partially removes the vehicle. The green shapes are then dried and sintered.

Rheological control of the suspension is of paramount importance. In the ceramic industry the rheology of the suspension is dictated by the interaction of the electrical surface charges on the particles which can be controlled by adjusting the pH of the slip. This condition may also result with metal powder slips if the powder particles are fine and covered with an oxide. However, if the particles have a metallic surface which will not support a charge or if the particles are too large, rheological control will be effected largely through variation of the solid/liquid ratio and by additions of gelling agents to increase the viscosity of the vehicle.

It is important to be able to predict the type of slip that will result from mixing a given powder with a particular vehicle so that a means of rheological control can be devised, and also to determine the type of absorbent mold to use. Slips controlled by chemical means readily part from the mold, but slips made from coarse or inert powder are not so easily removed. The mold sticking problem can be overcome by lining the mold cavity with some strippable medium such as paper, or a coating of ammonium alginate. With complicated shapes a better method is to use expendable paper molds.

The drying and sintering of the slip shapes poses no problem and conventional methods may be used.

Dr. St. Pierre believes slip cast powder shapes will not greatly differ in mechanical properties from shapes formed by conventional powder metallurgical methods and that slip casting offers interesting possibilities in alloying, both in the achievement of homogeneity and, where required, in manufacture of layer composites. Thus, under certain circumstances, slip casting may be applied competitively against traditional methods. *(Reported by C. Dixon for Ottawa Valley).*

Toolsteel Book Published

DIMENSIONAL CHANGES IN TOOLSTEELS during and after heat treatment are discussed in the book "Distortion in Toolsteels" just published by the American Society for Metals. Written by Bernard S. Lement, Manufacturing Laboratories, Inc., Cambridge, Mass., the book pays particular attention to methods of heat treatment necessary for precise dimensional control. Problems involved in producing toolsteels parts with tolerances less than one ten-thousandth inch are treated in detail.

The book's eight chapters cover such aspects of distortion as its basic nature, measurement, testing, quantitative prediction, control, relation to specific heat treating operations and occurrence on aging. The subject has been approached from a practical standpoint and the author has kept mathematical analysis to a minimum for effective presentation.

METALLURGICAL NEWS AND DEVELOPMENTS

COLORED STAINLESS STEEL

Although of primary interest to architectural users, the new colors available in stainless steels offer possibilities for many industries where the steel properties can be combined with the decorative effects of the colors. In one system, the color is provided through a chromate-base coating which can be sprayed, brushed or rolled on. A subsequent heat curing is required. A second method of applying color relies upon an acrylic film. The latter system provides a range of 11 colors, while the chromate system is now confined to brown and black with other colors to come soon.

LOW-TEMPERATURE BONDING

Specialists at Battelle Memorial Institute have developed methods of diffusion welding that make possible the obtaining of excellent bonds at temperatures as low as 650° F. A successful use of such low temperatures is as an intermediate metal in the bond. An example of an application of the new method is the joining of beryllium copper sheet to grooved Monel. Copper and silver were used as the intermediate materials in the joint with highly satisfactory results. The high-strength joints resulting from the process are satisfactory, in many instances, at temperatures well above the bonding temperature.

TANTALUM FOR HIGH AND LOW-TEMPERATURE USE

Metallurgists of Union Carbide Metals Co. report that tantalum can be considered for applications at both ends of the temperature scale. The extremes include —321 and 2000° F. These conclusions were reached after extensive study of the mechanical properties of both arc-melted and electron-beam melted tantalum. At the temperature of liquid nitrogen (—321° F.) the metal retains high strength, reasonable ductility and excellent notch toughness, regardless of melting method. Arc-melted tantalum appears to be superior at high temperatures. Tantalum is being used in chemical processing equipment, in the medical field and in electronics.

GOLD NEXT BUILDING COLOR

A new coating material for buildings is made of 23-carat gold is anticipated as the next trend in adding architectural color to new structures. The liquid gold can be applied to steel, stainless steel, ceramic tile, glazed brick, terra cotta structural glass and other building materials. The gold solution is applied by normal coating methods and then fired in an oven.

MORE SYNTHETIC DIAMONDS

A third source of man-made diamonds has now come into being with the announcement of the Norton Co. that is successfully producing the synthetic stones. However, for the time being the company does not anticipate commercial production.

DUCTILE CERMETS

In searching for a method of producing ductile metal-ceramic combinations, Stanford Research Institute has developed a new method which appears to offer considerable promise. The new type of cermet being investigated has randomly oriented laminated grains. Grains are formed by depositing alternating thin layers of metal and ceramic and crushing the laminate into grains. The grains are then used as in normal cermet fabrication. The new material is reported to have greater ductility at room temperatures than does a conventional cermet containing the same proportions of metal and ceramic particles.

ADOPTS WROUGHT DESIGNATIONS

At a recent meeting, the American Society for Testing Materials agreed to identify ASTM specifications for wrought aluminum alloys by the designations adopted several years ago by the Aluminum Association.

SEEK NUCLEAR STEELS

Atomics International and United States Steel Corp. are jointly searching for high-strength, low-cost steels for high-temperature use in nuclear power reactors. The approaches to the problem are through modifications of widely used chromium-molybdenum steels. Modifications are sought to increase high-temperature strengths of the steels and improve resistance to liquid sodium. Interest in the chromium-molybdenum steels is heightened because of their good heat conduction properties and because they do not expand as much in the same temperature ranges (1100 to 1200° F.) as steels currently used in the coolant piping of sodium-cooled power reactors.

MACHINABLE COPPER

A new sulphur-copper alloy that retains the high electrical conductivity of pure copper and also has excellent machinability and workability has recently been made available. Sulphur is present in the new alloy in the form of thin sulphide particles. In most of its characteristics the new alloy is said to resemble oxygen-free, high-conductivity copper.

Stainless Steel and Glass Will Sheath the $12 Million, 20-Story United Engineering Center Building Being Built in New York City. The Center, opposite the U.N. Building, will be headquarters for 18 engineering organizations with a combined membership of 300,000

Bomarc Missile System

JOHN F. BAISH, SUPERVISOR, Aero Space Division, Boeing Airplane Co., discussed "Materials and Processes Associated With the Development of the Bomarc Missile System" at San Diego.

The Bomarc missile is an important weapon of defense against missiles of similar type or against supersonic aircraft. Extensive ground installations are required for launching and guidance. The second generation, or "B" model, of the missile is presently being manufactured by Boeing in Seattle. A solid booster was developed to supplant the liquid booster used in the "A" model. Two ram-jet engines power both models during flight.

Conceived in 1945, the system pioneered as a defensive weapon. Many problems, encountered for the first time, required development of unique testing techniques to supplement available engineering data. For example, mechanical properties of candidate materials for the monocoque fuselage were determined under conditions of very rapid heating to high temperatures simulating aerodynamic heating.

Another problem to overcome was that of corrosion occurring during ground storage of missiles readied for firing. Minimum weight requirements dictated the use of welded structure for the boost fuel tanks; 17-7 stainless steel was selected for this application. This alloy provided required corrosion resistance without sacrificing strength and ductility. In service tests, tanks loaded with oxidizer acid for an extended period suffered no deleterious effects. Development of the solid propellant booster has reduced the complexity of that system, thereby increasing over-all reliability. A modified 4330 steel was used successfully for containment of the solid propellant.

The wings on the "A" model are composite structures of aluminum and magnesium. Supersonic airstream tests have demonstrated that aluminum wing skins as designed were subject to fatigue failure as a result of panel flutter. Magnesium skin components and minor design changes eliminated this difficulty. *(Reported by F. L. Brown for San Diego).*

Selecting the Right Steel

"FACTORS AFFECTING THE Selection of Steels" was the subject presented by Bill Hammer, metallurgical engineer, Earle M. Jorgensen Co., at a recent meeting held by the Tulsa Chapter.

Mr. Hammer emphasized that proper material selection is made on the basis of what steel will do the job most economically, and outlined the following factors as criteria for selection: properties attainable; ease of processing—machining on your equipment, response to heat treatment, fabrication characteristics; availability; and cost of material.

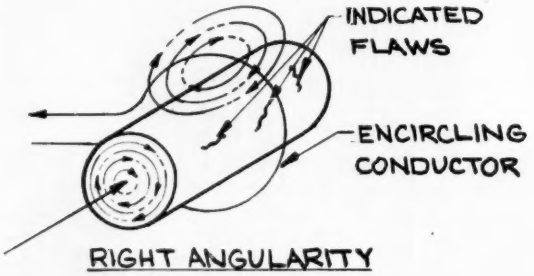
Although almost any analysis is available on a mill basis, only certain analyses are available from warehouse stocks. This fact should be definitely considered under the availability factor.

A general discussion of carbon, alloy, stainless and toolsteels readily available from warehouse stocks followed, and Mr. Hammer reviewed the wide range of properties available in these stocks. *(Reported by R. L. Kerwin for Tulsa).*

Magnetic Particle Inspection

"MAGNETIC PARTICLE INSPECTION" utilizes controlled magnetic field leakage to detect cracks, porosity, slag inclusions and other defects at the surface or reasonably close to it in ferromagnetic materials. Detection is accomplished by first setting up a magnetic field in the part to be tested, then applying a magnetic powder (either in dry or solution suspended form) to the surface of the part. Breaks and flaws in the part then disrupt the pattern of the magnetic lines of force, forcing them outside of the part, creating magnetic poles on either side of the flaw. These localized fields and the flaws that have caused them are then revealed by the way that the magnetic powder is attracted to them.

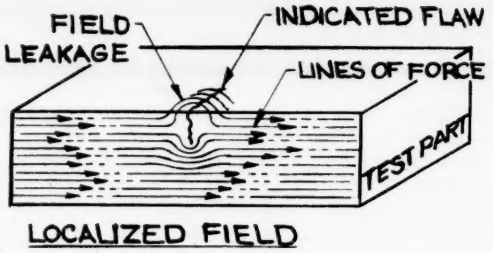
The above statements were made by John H.



Heller, field engineer, Magnaflux Corp., at a meeting held in Akron.

The relationship of the flaw to the magnetic field is very important, for if the flaw runs parallel to the field, the field will merely split and travel along either side. A condition of "right-angularity" (or nearly so) must exist between the flaw and the field for an indication to occur. In order to satisfy this requirement for all the flaws which might exist, a current is passed directly through the part, creating a circular field to detect longitudinal flaws, and another current is passed through an encircling conductor, creating a longitudinal magnetic field in the part to detect transverse flaws.

Chairman R. M. Moore, Technical Chairman M. Goldman and John H. Heller, Who Spoke on "Magnetic Partical Inspection" Shown at a Meeting in Akron



Magnetic particle inspection equipment is available for both a-c. and d-c. currents, the a-c. equipment being preferred when only surface defects need be found, as they are less costly than d-c. The magnetic powders are available in such colors as red, gray and black, to permit contrast with the part being tested. Mr. Heller noted further information helpful for magnetic particle inspection, as follows:

1. Recommended prod spacing (portable equipment) is 8 to 10 in. with 100 to 200 amps/in. of distance between prods.
2. Surface defects (to 0.010) will indicate neat and line like.
3. Subsurface defects (to 0.250) will indicate comparatively broad and fuzzy.
4. Generally speaking, a wide-mouthed defect will be less detectable than a narrow-mouthed.
5. A clean part surface is always helpful.
6. When detecting subsurface defects, use dry powder.
7. Parts tested with d-c. equipment require demagnetization afterward.

(Reported by C. F. Moewe for Akron).

Bonding Dissimilar Metals

A HISTORY OF THE BONDING of dissimilar metals was presented by Paul R. Chandler, engineer of tests, Lukens Steel Co., in a talk on "Bonding and Cladding" before the Dayton Chapter.

One of the more common techniques used in the past was to cast the more noble metal over the base material. The cladding of steel at Lukens Steel Co. dates back to 1931 when a combination of nickel and carbon steel was first introduced. Since that time, a succession of clad combinations have been provided, including Monel-steel, Inconel-steel, various austenitic stainless steels with steel, copper-steel and aluminum-steel. Most recently work has been accomplished on titanium-clad items.

In producing a stainless clad product by the process used at Lukens, two stainless steel layers are sandwiched between two layers of carbon steel, using the same proportional thickness as

Managing Directors Talk Shop

On a Recent Trip to the West Coast, A.S.M. Managing Director Allan Ray Putnam Dropped in at the West Coast Meeting of the American Iron and Steel Institute in San Francisco. While there he had a chance to discuss mutual plans and prospects with T. J. Ess, left, managing director, Association of Iron and Steel Engineers

desired in the final product. Careful preparation of all surfaces is necessary to assure good bonding. With some alloy combinations, scrupulously clean surfaces are all that is needed, since slight alloying of the alloys at the interface produces no deleterious properties. Where metallurgical problems may exist at the interface of dissimilar metals, it is often necessary to plate the clad insert surface with nickel to provide a buffer zone. In the case of a stainless steel-carbon steel combination, a slight nickel plate serves to prevent chromium build-up in the carbon steel and carbon build-up in the stainless steel, both of which detrimentally affect the clad piece. Alloys needing no special plating include nickel, Monel and aluminum. Cladding with various stainless steels, Inconel, copper-base alloys and titanium require a nickel plate.

When a sandwich has been prepared of successive layers of steel and the more noble material in question, it is heated to approximately 2250° F. and carefully rolled to the desired thickness. It is usually desired to reduce the thickness to at least one-sixth the initial thickness although a 10-to-1 reduction is preferred. Only aluminum-clad materials cannot tolerate reductions over one-third. The resultant sheet or plate is then sheared to the desired size and annealed to obtain maximum properties. All claddings are carefully handled to provide the same basic corrosion resistance as in base alloys.

Mr. Chandler emphasized the need for careful consideration when welding clad materials to make certain that the surface of the more corrosion resistant alloy is equally resistant to corrosives at all locations. A V-notch is generally used in preparing the pieces for welding, with the root of the notch at the surface of the more resistant material. The first bead (or beads, depending on total thickness) must be of the more resistant material and further welding is accomplished with carbon steel rods. Whenever possible it is advisable to use a rod richer in the basic elements comprising a specialty material to avoid damaging effects from slight dilution. For instance, weld rod of Type 309 stainless is used when welding Type 304 clad plate.

Many special tests are needed to evaluate clad materials and certain of the more interesting were discussed. A shear test is commonly employed to test the bond and all materials must withstand a 20,000 psi. minimum shear strength at this point. This particular minimum value is exceeded in most high-strength materials; for example, a Type 304 stainless-steel clad combination commonly exceeds 40,000 psi. shear strength. Various cyclic heating tests are also employed to check the bond of the clad materials and ultrasonic means are now used to make the same evaluation. Corrosion testing of clad materials has been an important evaluation and it has been definitely established that the clad piece invariably has the same basic resistance as stock made entirely of the more resistant material.

Considerable information was provided on the economics of utilizing clad materials in fabrication. For instance, a 10-15% stainless clad piece is only approximately 60% of the cost of a solid stainless steel sheet having the same general structural properties.

The potential use of clad materials was discussed in detail and was augmented by a movie entitled "Equip for New Profits", which illustrated the varied uses of clad materials where resistance to corrosion and contamination is required in high-strength materials. *(Reported by W. A. Luce for Dayton).*

Receives Scholarship

Leonard H. Milacek was awarded a $500 scholarship by the American Society for Metals at a recent Tulsa meeting. The scholarship, established in 1957 at Oklahoma University, is awarded annually to encourage students in the study of metallurgy.

Leonard, a junior, graduated from Waukomis High School and served two years in the Army. He is married and lives in Norman.

Electron Beam Welding–Apparatus and Application

"ELECTRON BEAM WELDING" was the subject of the talk at a joint meeting of the Washington Chapter and the Washington Section A.W.S., by A. Lesnevich, supervisor of welding research, Air Reduction Central Research Laboratories. Dr. Lesnewich was the recipient of the A.W.S. Lincoln Gold Medal for the paper contributing most to the advancement of welding in 1958.

Dr. Lesnewich pointed out the similarity of the electron beam welding process to a cathode ray or television tube, in which the beam current is of the order of a millionth of an ampere at a potential of about 15 kilovolts. More than 50 years ago, von Pirani used the electron beam to fuse tantalum powder for which he was granted a patent in 1907. The Carl Zeiss Co. modified an electron microscope before 1950 to use the electron beam for punching holes in sapphire and other refractory materials. The Zeiss unit, used some time later for welding, had an electron gun with focusing coils, producing a beam current of 10 milliamperes at 100 kilovolts accelerating potential. At about the same time, the British used electron beam methods for zone refining.

The first use of the electron beam for welding in the United States was developed by Wyman at General Electric's Hanford Works for joining Zircaloy. The required freedom from oxygen could not be maintained with conventional methods of welding. It appeared that the obvious solution would be to weld in vacuum. However, since an arc or flame cannot be maintained in a vacuum, other methods of heating the work to welding temperature were needed. The first electron beam welding apparatus used a simple electron gun with the work as the anode. The short focal length of this type of apparatus led to difficulties in control of the electron beam at higher currents because heat reflected from the work raised the filament temperature and metal vapors from the weld collected in the gun to cause fluctuations of the emission, if not complete loss of control. Also, a longer focus is desirable to allow space for jigs and fixtures to position and move the workpieces.

In experimental apparatus developed at Airco Laboratories, a longer focal length and better control of the electron beam were obtained by use of electron guns having a control grid, a separate accelerating anode and electromagnetic coils to focus the beam on the work. These units

Harry L. Ingram, Technical Chairman, Is Shown With A. Lesnewich (Right), Supervisor of Welding Research, Air Reduction Central Research Laboratories, in Washington

have a maximum accelerating potential of 15,000 volts. At beam currents high enough for heavy welding, however, "boiling" of the workpiece sometimes caused flash-over in the electron gun. In a later model this difficulty was remedied by enclosing the electron gun and the work in separate vacuum chambers, connected by a plate with a small aperture, so that a high vacuum could be maintained in the gun chamber. The electron beam is focused on this aperture and the divergent beam emerging from the aperture is refocused on the work by a second adjustable focusing coil.

Dr. Lesnewich outlined several advantages of the electron beam process. Its major use is expected to be for welding, melting and zone refining the reactive metals and for processes in which high purity must be maintained. The process can also be used for welding ceramics and cermets, since electrical conduction is not required. The method is useful for precision work, such as welding of small electronic parts, and for high-speed welding, because the electron beam does not wander like an arc. Two systems of electron beam welding are under development: high voltage, and low voltage with relatively higher current. Dr. Lesnewich feels that each system has its advantages, and that the two systems will complement each other in serving industrial needs. *(Reported by M. L. Williams for Washington).*

Natural Media Corrosion of Ferrous Materials

MEMBERS OF THE TEXAS CHAPTER heard C. P. Larrabee, chief research engineer, corrosion prevention, Applied Research Laboratory, U. S. Steel Corporation, give a talk entitled "Natural Media Corrosion of Ferrous Materials".

C. P. Larrabee (Left), Who Spoke on "Natural Media Corrosion of Ferrous Materials" at a Meeting in Texas, Is Shown With Chairman Gilder

Mr. Larrabee discussed the effects of the many variables that influence the corrosion of steels in the different media—atmospheres, waters and soils. Methods used in testing steels in these media were illustrated.

The corrosion resistance of several commercial and experimental high-strength low-alloy steels were compared with those of structural copper and carbon steels in the same environments.

The speaker emphasized the point that for each application the environment and composition must be considered. When tests are to be made, they should be made under normal use and conditions as would be found in service.

The talk was concluded with an outline of methods which may be used to prevent steel from corroding. He pointed out that designs should endeavor to eliminate all chances for corrosion. *(Reported by C. J. Schoppe for Texas).*

Research in the Materials Field by Design Engineers

RECENT EMPHASIS IN MATERIALS RESEARCH has been in response to needs for special materials for special purposes. Under ideal circumstances, a designer would like to be able to design a machine or structure or develop a process without regard to limitations imposed by the properties of existing materials. While this is not likely ever to be possible, considerable progress is being made through the cooperation of designers and materials engineers. Cooperation takes several forms. The designer can provide a clear description of what he wants. The materials engineer can define the limitations within which the available materials can be expected to perform satisfactorily. Having thus defined clearly what is needed by way of new or improved materials, their development is expedited and they are put to use with a better chance of early, as well as ultimate, success. The above statements were made in a talk given by Frank L. LaQue, International Nickel Co., at a meeting of Oak Ridge Chapter on "Research in the Materials Field".

Mr. LaQue pointed out several examples of where cooperation between the design and the materials engineers had resulted in a more expedient solution to a particular problem. For example, the Inor series of alloys was developed by the combined efforts of the Oak Ridge National Laboratory and the International Nickel Co. in response to clearly defined needs for a material to resist a specific environment under certain conditions of temperature and stress. In several areas the progress is dependent on the development of new materials. For example, the steam power industry needs materials to enable them to reach higher operating temperatures and pressures and space travel is certainly dependent upon the development of new materials.

Under stimulation of the type described, Mr. LaQue pointed out several immediate purposes why materials research is undertaken.

1. To measure properties of materials, including corrosion and mechanical behavior.
2. To improve existing materials to obtain properties which are suitable for a particular application.
3. To create new materials.
4. To choose materials for specific purposes with respect to corrosion resistance, strength, ductility, etc.
5. To diagnose difficulties and develop remedies for them.

The remainder of the talk was devoted to discussing several very interesting examples to illustrate research for each of the above purposes. *(Reported by H. E. McCoy for Oak Ridge).*

Engineering Properties of Carbonitrided Cases

"ENGINEERING PROPERTIES OF CARBONITRIDED CASES" were discussed by K. B. Valentine, metallurgical engineer, Pontiac Motor Division, General Motors Corp. at Detroit.

Mr. Valentine emphasized the engineering properties of carbonitrided cases obtained in parts from well-established, high-volume manufacturing operations. He reviewed the vital significance the surface layer of a material has upon its engineering properties, and emphasized through a series of examples the interrelationship existing between fatigue life, resistance to wear, toughness, frictional properties, case depth, shot peening and surface defects, due to the fact that they are what might be termed surface sensitive characteristics or phenomena.

Kenneth B. Valentine (Right), Pontiac Motor Division, General Motors Corp., Who Spoke on "Engineering Properties of Carbonitrided Cases" at Detroit's Educational Series, Shown With Technical Chairman Sheils

Mr. Valentine went into some detail regarding generally accepted theories, explaining the reasons for the effectiveness of hardened cases in decreasing friction and wear, particularly as concerns carbonitrided cases. He also described a relatively simple laboratory method for determining relative frictional characteristics of various materials and heat treating processes utilizing a nut, bolt and spacer assembly. By tightening the assembly, the elongation of the bolt is measured at increments of torque, thus the relative frictional properties of the mating surfaces at the threads can be calculated. By this technique, the coefficient of friction for carbonitrided parts was established at 0.163, cyanided parts 0.243, and a plain bolt 0.315.

The next property discussed was the resistance to wear and the very satisfactory experience encountered to date with a carbonitrided stamped rocker arm ball in regard to friction, wear and dimensional stability.

Fatigue properties of carbonitrided components were reviewed. The limitations of carbonitrided cases for applications where impact fatigue exists, such as rocker arms and push rods, were emphasized, and the need for a better understanding of the reason for this shortcoming noted. The metallurgical notch characteristics of surface carbides, plus the different phase compositions of the outer layer resulting in reduced residual compressive stresses due to transformation, may offer some explanation for the poor performance of carbonitrided cases in endurance-type applications.

Mr. Valentine then described the technique of evaluating toughness, or its converse, brittleness, in case hardened parts by a bend test technique involving the standard notched Izod impact test specimen. An incremental loading technique, coupled with a 45 × magnification examination of the notch at each 500 lb. increment revealed three basic types of failure from such loading.

1. Ductile fractures where cracking occurs only in the case after some degree of permanent set of approximately 0.003-0.005.
2. Brittle failure where the specimens break through the case and the core.
3. Brittle failure where cracking of the case occurs without a discernible permanent set.

Mr. Valentine closed his presentation with a few comments on "tolerance", the term used to describe the capability of a process or specific heat treatment to compensate for a wide variety of grades of steel used, surface cleanliness, variations in size and shape, etc., and yet produce a reasonably consistent end result. *(Reported by Robert E. Mahr for Detroit Chapter).*

Explosive Working of Metals

FUNDAMENTAL ASPECTS OF FORCES, pressures, velocities and similar topics which are basic to the explosive working of metals, were covered in a talk by John Pearson, head, Detonation Physics Group, U. S. Naval Ordnance Test Station, at a meeting of Albuquerque Chapter on "The Explosive Working of Metals". He described a number of the different types of operations, ranging from the research to the production state, and some of the material behavior patterns related to these operations.

Regarding energy sources, the major break-

A Class in Heat Treating of Steel Held at Worcester Polytechnic Institute Under the Sponsorship of Worcester Chapter. The instructor, standing against the wall at the far left, is Roy F. Bourgault. About 42 members attended this M.E.I. course

down of explosive types most pertinent to metalworking is into high explosives and low explosives. A high explosive can be typified by TNT, PETN or dynamite. Common examples of low explosives are smokeless powder and black powder. A high explosive detonates, producing extremely high pressures in the order of from 2,000,000-4,000,000 psi. A low explosive burns or deflagrates, producing much lower pressures, in the order of about 40,000 psi.

Operations can be divided into two main groups, depending on the position of the explosive charge relative to the workpiece. The first group consists of those operations where the charge is placed in intimate contact with the workpiece and may be referred to as "contact operations". The second group includes those operations where the charge is located some distance from the workpiece and the energy is transmitted through an intervening medium (e.g., water). These may be appropriately classed as "standoff" operations. The types of explosive operations most used in current production include the forming, sizing and flanging of sheet metal stock and plate. All of these are normally standoff operations. Other operations in varying degrees of usage or advancement are controlled work hardening, forging, extruding, welding, controlled cutting and the compacting and forming of powders. Most of these, but not all, can be considered as contact operations.

Explosive working is not a cure-all for all of the problems which exist in the conventional working of metals, although it does offer help in many cases. In many types of operations it is not a replacement for the older method, merely an adjunct to it which allows for greater scope of operation. In other instances it promises revolutionary new and exciting techniques yet to be established. It is safe to say that if a job can be satisfactorily and economically performed by older, more conventional methods, then explosive working is not needed. However, if conventional methods are not now doing a satisfactory job, then explosive working should be seriously considered; in many cases it will offer a completely satisfactory solution. Advantages include: adaptability to short-run items and small jobshop operations; good uniformity of product from part to part; closer tolerances to finished parts; and small capital investment required for many operations. The main disadvantages are: safety hazards from handling explosives; and techniques restricted, in many cases, to operation outside of a city or town due to local ordinances. *(Reported by E. H. Mebs for Albuquerque).*

Patents and the Modern Engineer

JOSEPH GRAY JACKSON, patent law attorney, spoke on "Patents and the Modern Engineer" at York. He discussed patents and their use in various fields of metalworking.

A patent is fundamentally a contract, it does not give an individual the right to manufacture or sell a product connected with his patent, but only protects his constitutional right to exclude others from making, selling or using a patented process, machine, article or composition without authorization.

Mr. Jackson discussed the five basic types of patents—new processes, new machinery, manufactured articles, material composition and improvements in the forementioned areas.

To illustrate how a patent is secured, Mr. Jackson reviewed the experience of Mr. Wyatt in his discovery and patent application of the submerged channel induction furnace. He explained the problems Mr. Wyatt encountered with the experimental furnaces and his subsequent problems in securing a patent, making the patent claim and search, a claim rejection, an amended claim and final patent approval. *(Reported by A. W. Kollosch for York).*

Defines Explosive Metal Forming at Boston

John Chipman, Past President A.S.M., Vasil Philipchuk, Who Spoke on "Explosive Metal Forming", and W. A. Backofen, Technical Chairman, Shown at a Meeting in Boston

RESEARCH AND DEVELOPMENT IN ammunition and high-altitude explosives were forerunners to the work now being done in metal forming, according to remarks made by Vasil Philipchuk, manager, Special Projects Dept., National Northern Division, American Potash and Chemical Corp., at a meeting of Boston Chapter.

Mr. Philipchuk opened his talk with a discussion of how a manufacturer of fireworks became a leader in the field of explosive forming. Explosive forming of metal parts came into being in late 1954 when an attempt was made to develop a more economical procedure for producing rocket nozzles than by hogging from solid blocks. The success of this venture can be judged by the fact that today the process is capable of forming to predetermined shapes parts ranging in weight from a few grams up to two tons each. As an example of a large-sized explosive formed item, Mr. Philipchuk showed a slide of a heavy-wall stainless tube with wall thickness of 4 in., the diameter of which was expanded by 30%.

In production of explosive formed metal parts, a female die in the shape of part to be formed is required. For short runs, an easily machined plastic die can be used, although this type of tooling requires a great amount of repairing if more than a few pieces are to be produced. Tools are generally made of a tough toolsteel heat treated to hardness of Rc 20-30, and capable of production quantities without need of repairing. With the metal blank in position in the die, the assembly is covered with water. Then the explosive charge, which is sometimes cast into a special shape, depending on the article to be formed, is set off in the water by a blasting cap, which ignites the main charge. Explosive force exerted in the water is transmitted through water, causing water pressure on the blank, which in turn causes the metal to flow plasticly to the shape of the die. Physical properties of explosive formed metal are approximately the same as mechanically cold worked properties of the same material. Almost every configuration can be made by this process. Spring-back is so slight that some parts formed in this manner can be welded without distortion.

Metals which have been successfully explosive formed include mild steels, stainless grades, toolsteels, aluminum, manganese, titanium, molybdenum, tungsten and many other pure metals. The super alloys of the jet engine programs are an example of where the process is successfully applied. Housings for the J93 engine are produced in this manner.

Dimensional tolerances can be maintained to plus or minus 0.001 in. for critical applications, or for noncritical dimensions the tolerances may be stated in fractions of an inch. Mr. Philipchuk told of a recent experience in which a tolerance of 0.010 in. was maintained on a 43 in. diameter part. The tolerances which are required for a part are a large factor in determining the cost of producing the part by this method. In general, the cost of maintaining close tolerances is higher than when liberal tolerances can be accepted.

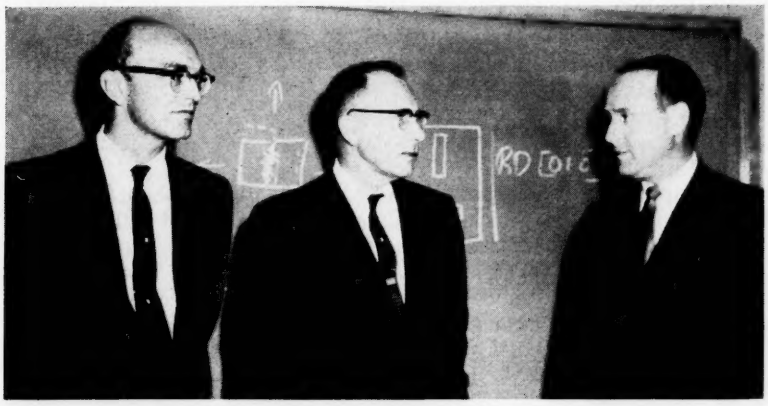
New applications for explosives in metals fabrication are now being developed. Expected shortly is a report on the explosive forming of aluminum in which tensile strength of 85,000 lb. per sq. in. and elongation of 15% are developed. Pressure welds are being produced by explosives wherein the weld area is only 0.0001 in. thick and with no heat affected zone. Dissimilar metals are being welded in this manner, and the possibility exists that refractory metals will be welded by this procedure. In the powder metallurgy field explosives are being used for compacting powders for missile and rocket parts, eliminating the sintering operation, and producing densities in excess of 95%. Currently under development is a method for extruding metals, using explosives as the driving force.

In conclusion, Mr. Philipchuk stated that success in any given project is quite apt to be a matter of cooperation between the design engineer and the project engineer. It's a new science. *(Reported by Daniel A. Black for Boston).*

Creep and Deformation of Metals Reviewed

EARL PARKER, PROFESSOR, University of California, past national trustee A.S.M., presented a talk on "Creep" at Los Alamos. Dr. Parker is also director of the Institute of Engineering Research.

Dr. Parker explained the true reason which disproves a past theory that small grains inhibit creep at lower temperatures and enhance it at higher temperatures. He said the true reason for increased creep at higher temperatures with small grain sizes is the fact that the formation of larger grains removes boundaries having higher surface energies previously associated with small grains. Annealing to produce large grains leaves only grains with lower energy boundaries. Dislocation climb is slower near low-energy boundaries and hence creep is slower. *(Reported by Paul Mundinger for Los Alamos).*



Earl Parker, University of California, Presented the Second Lecture in the Los Alamos Chapter's Series on "Creep". He is shown, center, with Tom Jones, technical chairman, right, and Al Gorum, on the left

The talk was prefaced with a general description of creep as being basically the same as the deformation of metals at ordinary temperatures. A physical rather than chemical approach to the phenomenon of creep was made in terms of the dislocation theory and what happens to the dislocation of a material as a function of temperature.

The dislocation climb process was presented as a means of inducing creep with an increase in temperature. The activation energy for self-diffusion determines the process for flow as being that of creep. Grain boundaries and areas of stress concentration are common sources for fracture because of localized high concentration of dislocations there. By means of an electron microscope, and using a transmission technique, dislocations can be observed in polished, unetched 1 micron foil. Slides of electron micrographs showed that localized dislocations were present in groups. Certain work hardening processes, caused by dislocation interactions, were covered.

A means of retarding creep by the process of back-stress from a concentration of dislocation was discussed. This back-stress counteracts an external force and thereby retards flow. "Cross-slip" was defined as a means of the movement of dislocations from one plane to another in f.c.c. metals under high stress or with milder temperatures.

Modern Plastics

AN INTERESTING DISCUSSION OF today's plastic picture was presented by K. F. Charter, assistant director of the reinforced plastic development department, A. O. Smith Corp., at a Tri-City meeting. At present, one of the research efforts is being directed towards the development of a plastic pipe reinforced with glass fiber.

Plastic materials are not expected to replace metal where strength is necessary, but plastics can be substituted for decorative effects and for trimmings. Color can be made permanent by adding pigment to the plastic material.

Some of the advantages on the side of plastics are: light weight, rust resistance, crack resistant, permanent colors and ease of forming or extruding.

The plastic industry is comparatively new. Plastics were first generally accepted in the 30's and machinery for extruding and forming of plastics came into use in 1939. Standardization of the many plastic types and grades continues to be a huge problem. Growth in plastics has been rapid. In 1956, the amount of plastic produced totaled 57.6-million cu.ft. compared to 27.9-million cu.ft. of nonferrous metals. *(Reported by R. K. Paton for Tri-City).*

Augustus B. Kinzel to Head Engineers Joint Council–1960

Augustus B. Kinzel, member and recipient of many honors in the American Society for Metals, has been elected 1960 president of the Engineers Joint Council, federation of engineering societies having a total membership of 300,000 engineers. He is vice-president, research, for Union Carbide Corp., New York.

One of the nation's outstanding research metallurgists, Dr. Kinzel pioneered in the theory of stainless steels, and the theory and application of the structural low-alloy steels and new ferro-alloys. He spearheaded the research that led to the development of Union Carbide's process for making titanium metal.

He began his career with Union Carbide in 1926 as a research metallurgist for the corporation's laboratories and became chief metallurgist in 1931. After holding executive positions in several Union Carbide divisions he became vice-president, research in 1955. His research contributions at Union Carbide have covered a wide range of activities in the fields of metallurgy, industrial gases, applied mechanics and atomic energy. Before joining Union Carbide he was associated with General Electric Co. and Henry Disston and Sons, Inc.

A member of the original Manhattan District Committee for the World Control of Atomic Energy, he helped draft the classified report that was the working basis for the Lillienthal and Baruch plans. He has served as consultant to various Atomic Energy Commission installations, including the Los Alamos, Oak Ridge, Argonne, Knolls and Brookhaven Laboratories. Presently he is a member of the Naval Research Advisory Committee of which he was chairman, 1953-1954.

Metal Progress, A.S.M.'s metals engineering monthly, presented a biographical appreciation of Dr. Kinzel in August 1953. The magazine said at that time: "A rare ability to beneficiate the thinking of his associates, plus a brilliant knack for channeling theoretical physics into industrial practice, has placed Augustus Braun Kinzel among this generation's prime metallurgists. He is a scientist-executive whom his professional colleagues continue to honor."

And honor him they have—with the A.S.M. Campbell Memorial Lectureship, A.S.M. Distinguished Service Award, *Metal Progress* Hall of Fame membership, and A.S.M. Burgess Memorial and Sauveur Lectureships. He has given other honorary memorial lectures in metallurgy, including the HOWE (A.I.M.E.) and the Adams (A.W.S.). He is also a Samuel Wylie Miller medalist (A.W.S.), a James Turner Morehead medalist (I.A.A.) and a Stevens Institute of Technology Powder Metallurgy medalist.

He is receiving the Industrial Research Institute Medal this month, and also was presented the James Douglas Gold Medal of the A.I.M.E. in February. An accomplished linguist, Dr. Kinzel has lectured to engineering audiences in many countries abroad.

In addition to his membership in the New York Chapter of the American Society for Metals, Dr. Kinzel holds membership in many engineering societies. He is past chairman of the Engineering Foundation Board, the Welding Research Council, and past president of A.I.M.E. and former vice-president of the International Institute of Welding.

Dr. Kinzel is also an honorary member of the British Acetylene Association and chairman of the advisory committee to the Institute of Mathematical Sciences of New York University.

Dr. Kinzel is a member of the Engineers Club, the University Club and the Racquet and Tennis Club of New York City, the Cosmos Club of Washington, the Niagara Club, the Pittsfield

Country Club, and several art museums and musical associations. He is a director of the Berkshire Farm for Boys and the International Benjamin Franklin Society.

Dr. Kinzel is co-author of the Engineering Foundation's volumes on "Alloys of Iron and Chromium" and is the author and co-author of more than 60 technical papers. Over 40 patents have been issued in his name.

He lives at 4 East 70 St., New York City, and also has a home at Lake Queechy in the Berkshires and La Jolla, Calif. He and his wife, Marie McClymont Kinzel, have a son and five daughters. For relaxation Dr. Kinzel designs and builds modern furniture, sails dinghies and pilots small planes.

Metals Review is proud to salute Dr. Augustus B. Kinzel, "one of this generation's prime metallurgists".

History and Applications of Electron Beam Welding

THE SIMILARITY BETWEEN ELECTRON beam welding equipment, X-ray tubes and electron microscopes were described in a talk by W. Farrell, chief application engineer, Sciaky Bros., Inc., at a meeting held recently by the Long Island Chapter.

Mention in literature of the use of electron beam for melting is contained in a United States patent dated Mar. 26, 1957, granted to Marcello Von Pirani, an Italian working in Berlin. This patent described electron beam vacuum melting of tantalum, or other metal, to produce a pure ductile homogenous body of refractory metal. To the best of the speaker's knowledge, the first utilization of the electron beam for welding was accomplished by J. A. Stohr of the Atomic Energy Commission of France. Mr. Stohr applied for a patent on electron beam welding in January 1956. A French patent was granted against this application.

Tungsten arc and filler arc require ionized particles for proper operation and, therefore, will not operate in a vacuum, whereas electron beam welding cannot operate unless a vacuum of 0.1 micron or better is maintained. This gives the process a self-regulating feature.

Further comparison between electron beams and argon arc welding revealed that the new method delivers higher energy, 3000-5000 kw/sq.in., over a smaller area (argon arc 55 kw/sq.-in.) and has a narrower weld and heat affected zone.

The electron beam welding process consists of conversion of the kinetic-energy of a high-velocity beam of electrons to heat when the accelerated electrons strike the surface of the workpiece. As with electron beam melting, vaporization and deoxidation phenomena occur within a localized area. There is no field between the gun and the work which are at the same potential; therefore, the emitter is not coated by the metal vapor. The equipment is operated by evacuation of the work chamber to less than 0.05 micron pressure, adjustment of the filament current to a predetermined emission, direction of the beam by positioning the gun and activation of the electromagnetic lens. Typical power requirements for welding ⅛-in. thick molybdenum to itself at a speed of 12 in. per min. were also covered.

The unique characteristics of the high-voltage electron beam welding process point to several joining application areas, namely: refractory metals, high thermal conductivity metals, highly reactive metals and welds not possible with conventional processes. *(Reported by F. A. Hallock for Long Island Chapter).*

Rocky Mountain Hears Talk—What Is Lubrication?

SPENCER MILLIKEN, coordinator of research and sales, Foote Mineral Co., spoke before the Rocky Mountain Chapter on the subject, "What Is Lubrication". William Mueller, Denver Research Institute, presided as technical chairman of the meeting.

Dr. Milliken prefaced his talk with the statement that lubrication at the present time is mostly an art with little known of its scientific aspects. Lubrication is basically a study of surface or physical chemistry. The degree of lubrication depends on many factors, among which the more important are viscosity of the fluid, smoothness of the mating surfaces, lowest melting point of the metals used and the type of fluid or additives used.

The basic properties of lubricants are affected by temperature and pressure, with paraffin-based materials affected least. Additives used for certain applications are viscosity additives to maintain constant viscosity, oiliness additives which give the effect of higher viscosities, and E. P. additives of sulphur, chlorine or phosphorous compounds which reduce temperature effect.

Three main conditions of lubrication exist; the fluid area in which viscosity is most important, the semifluid area in which fatty acid additives and chemical films are used and the boundary layer conditions under which chemical, metallurgical or gaseous phases of lubrication govern. *(Reported by L. G. Loseke for Rocky Mountain).*

Welding Methods—Their Use in Metalworking

"RECENT DEVELOPMENTS IN WELDING METHODS" were presented at Chicago-Western's educational series by C. E. Jackson, associate manager of electric welding, Newark Development Laboratory, Linde Co.

Welding should be viewed as an integral part of any metalworking operation in the fabrication of a product. Thus the parts to be welded may have been cast, rolled, flow formed, hot formed, etc., or any combination of these processes.

Welding had its beginning in 1809 when Humphrey Davy described the first electric arc. Actually the first carbon arc welding disclosure was not made until 1888. This was followed by such developments as the metallic electrode in 1892, gas welding in 1900 and covered electrodes in 1907. The modern covered electrode as we know it today was introduced in 1912. Most of the early developments took place in Europe; however, inert gas welding, and similarly, submerged gas welding, were developed in this country. Free European countries are presently using American methods, with some modifications to suit their needs, and they are also developing their own processes.

A series of color slides taken during a recent trip through Europe and Russia illustrated welding operations involving the joining of ship structures, bridges, railroad cars and rails, etc. He then presented cost comparison figures, and stated that we cannot compete with European ship builders in spite of our more efficient method because of their lower labor costs.

Welding research in Europe is conducted in several universities by independent groups rather than by cooperative team work as is done in this country.

Russian welding equipment and methods are quite similar to American ones. However, there are some differences, such as their effort to use CO_2 welding for most mechanized units, whereas argon atmosphere might be considered preferable in this country. Similarly, electroslag welding is used quite extensively for heavy plate joining. A new approach to joining is friction welding which consists of keeping one rod stationary and bringing into contact with it another one rotating at 15,000 rpm. The heat which is generated promotes welding of the two in a structure which resembles flash welding. Plasma welding is being investigated in Russia as it is in the U.S.A.

Mr. Jackson concluded with the statement that welding in Europe is similar to the U. S., but the labor picture is more favorable in Europe and consequently they can compete advantageously with us in many fields. *(Reported by D. J. Garibotti for Chicago-Western).*

Minerals of New Mexico

ALVIN J. THOMPSON, DIRECTOR, New Mexico Bureau of Mines and Mineral Resources, spoke on "Lands and Minerals of New Mexico" at a meeting at Albuquerque.

Twenty-six million acres in New Mexico are still owned by the Federal Government, about one-tenth of which is defense land, the remainder national forests and public domain land. Within the latter, an appreciable part of the oil, gas and potash of the State is found.

At one time, a large part of the privately owned land in New Mexico was owned by the railroads, and about one-sixth by the State. These lands have been an important source of the revenue of the State (about thirty million dollars).

The progress of the mineral industry in New Mexico has been phenomenal. Since 1925 the value of mineral production has risen rapidly. At present mineral property is 2½ times the value of agricultural property, while in 1946, the value of agricultural property was twice that of mineral property.

New Mexico ranks third among the Western states in mineral production. In the period from 1954 to 1959 the annual value of mineral production rose from 380 million dollars to more than 600 million dollars. In this same period, manufactured products in the State rose from 200 to 300 million dollars and agricultural products remained at approximately 200 million dollars annually.

Prior to 1900, gold and silver accounted for 80% of the mineral production; in 1930, copper accounted for 70%; in 1950, oil ranked first; potash second; in 1960, uranium ranks second to oil, which is still first.

New Mexico ranks eighth in the U. S. in oil production, third in gas production and first in uranium production. Coal reserves are estimated at 60 billion tons.

An important mineral product is potash, with areas of production centered around Carlsbad. Copper, another important product, is principally from the Chino Mine (Kennecott Copper Co.), close to the Arizona line. This is a low-grade ore running approximately 0.8% copper. Zinc and uranium minerals are also produced in substantial quantities.

The Grants area, where uranium was discovered in 1950, may become a billion-dollar mining camp. *(Reported by E. H. Mebs for Albuquerque Chapter).*

Technical Aspects of Aluminum

DANA W. SMITH, Dept. of Metallurgical Research, Kaiser Aluminum & Chemical Corp., spoke on "Some Recent Technical Developments in the Aluminum Industry" at a Chicago Chapter meeting.

Primary aluminum production rose to 2,000,000 tons in 1959 from a war-time peak of 920,000 tons. Technical developments were responsible for this rapid growth, especially in the field of welding where two important processes were developed during the war: namely, automatic feed and tungsten electrodes.

Formerly, there were two alloy groups, common and high strength. There was growing demand for alloys to bridge the gap between these, so aluminum-manganese alloys were produced for weld joining.

Some properties of the alloys are improved tensile strength at low temperature, decreased elongation and increased impact values as the temeprature is decreased.

Many important and useful applications are possible with these alloys including storage and transport of gases and liquid oxygen, structure and armor plate of Army vehicles to provide greater speed and economy, small marine craft with good corrosion resistance, automobile trim, and finally, architectural uses.

With reference to architecture, new anodizing techniques have produced some pleasing colors, especially pale blues and golds. *(Reported by G. W. Graves for Chicago).*

Strengthening Mechanisms in Solids—1960 A.S.M. Seminar

All arrangements for the 1960 A.S.M. Seminar are now completed, according to Julius J. Harwood, Seminar coordinator. The subject of this year's Seminar is "Strengthening Mechanisms in Solids". A highlight of the program will be the appearance of Prof. J. Nutting of the University of Cambridge, England, who will deliver a paper on "Strengthening Mechanisms as Observed Directly by Electron Transmission Microscopy".

Seminar sessions are to be held at the Bellevue-Stratford Hotel, Philadelphia, Oct. 15 and 16, the Saturday and Sunday preceeding the opening of the National Metal Congress and Exposition. Papers scheduled for presentation are: "Introductory Review of Strengthening Mechanisms", W. R. Hibbard, Jr., General Electric Research Laboratory; "Solid-Solution Strengthening", P. A. Flinn, Westinghouse Research Laboratory; "Strengthening by Work Hardening", J. Washburn, University of California; "Strengthening Mechanisms as Observed Directly by Electron Transmission Microscopy", J. Nutting, University of Cambridge, England; "Radiation Hardening", G. H. Vineyard, Brookhaven National Laboratory; "Vacancy Hardening", R. Maddin, University of Pennsylvania; "Strengthening by Martensitic Transformations", V. F. Zackay, Ford Scientific Laboratory; "Strengthening by Precipitation Reactions", W. D. Robertson, Yale University; "Fine Particle Strengthening", R. W. Guard, General Electric Research Laboratory; "Hardening Effects Produced With Shock Waves", G. E. Dieter, E. I. duPont Engineering Research Laboratory; "Strengthening Mechanisms in Ionic and Inorganic Solids", T. L. Johnston, C. Li and R. Stokes, Minneapolis-Honeywell Research Center; and, "Role of Surface Effects in Strengthening Mechanisms", E. Machlin, Columbia University.

Gases in Steelmaking

THE BEHAVIOR OF GASES in the steelmaking operation, the heart of the steelmaking process, was reviewed by T. F. Kaveney, manager of electric furnace service, Union Carbide Metals, at an Akron meeting, in a talk entitled "Trends in Modern Steelmaking".

Mr. Kaveney first discussed the use of oxygen for carbon control and removal of undesirable inclusions. Then, assuming that the oxygen has done its work, he discussed the role of the various deoxidizers and their limitations. Carbon is probably one of the better deoxidizers as the carbon-oxygen relationship is one that is not readily affected by temperature changes. Silicon is not a strong deoxidizer, especially where the high-carbon steels are concerned. Manganese as a deoxidizer is a poor choice; however, manganese is great for tying up sulphur. Manganese in combination with either silicon or aluminum produces a very good deoxidizer.

It has been found that hydrogen severely affects the physical properties of steel. This has been especially true of electric furnace batches. Hydrogen is usually introduced through a moist condition, such as a moist atmosphere. Lime in the bath will pick up this moisture and consequently the hydrogen. It helps to use burnt lime, and to receive the lime in sealed containers, using up the lime as soon as possible after the container has been opened. Deoxidized steel is prone to hydrogen pickup. Magnesium is used as a hydrogen controller, but is temperature sensitive.

Nitrogen is detrimental to steel quality in general. Nitrogen is picked up from the atmosphere; although a bath is not prone to pick up dry nitrogen. Electric furnace steel is vulnerable to the nitrogen problem. The controlling factor of the nitrogen content is the composition of the steel itself. *(Reported by C. F. Moewe for Akron).*

Early Exhibitors Announced for 1960 Philadelphia Metal Show

SIXTEEN FIRMS REPRESENTING the largest concentration from the steel industry in the 42-year history of the A.S.M. Metal Shows have already reserved display space for the 1960 event, to be held Oct. 17-21, in the Philadelphia Trade and Convention Center.

Along with this heavy steel industry participation, leading firms in many other areas of the metal industry have reserved major display spaces in the 1960 Metal Show, according to A.S.M. Managing Director, Allan Ray Putnam, in releasing an early roster of exhibitors.

In Putnam's opinion, the Metal Show will stand as a vital and realistic mirror of today's metal industry, and will reaffirm the basic aims of the American Society for Metals to provide valuable educational-informational lines of communication for its members.

Accentuating the dynamic quality of the Exposition will be the 42nd National Metal Congress, held concurrently with the Metal Show. Its projected 221 technical papers, panels and symposia will be carefully selected to present the most significant developments in metal science and engineering during the past year.

Putnam points out a special area of the Metal Show, known as the Steel Arena, will have as its theme *"Build It Better With America's Steel —Basic Material of Construction."* It will be a dramatic showcase revealing the multiplicity of steel applications in the home, industry and outer space. This dramatic story of steel will attract not only the users of steel but also of nonferrous metals and nonmetallic materials.

In addition to steel, the 1960 Philadelphia Metal Show exhibitors will represent ten other carefully defined metalworking categories to generate a definite "metals personality and atmosphere" in the Metal Show. Others are:

Nonferrous metals, related engineering materials, nucelar materials and equipment, tool materials for cutting off and forming, industrial heating, cleaning and finishing, welding and joining, testing, inspection and control equipment, production and casting, parts, forms and shapes for design.

Exhibitors from the steel industry include to date: Allegheny-Ludlum Steel Corp., Babcock & Wilcox Co., Braeburn Alloy Steel Corp., Carpenter Steel Co., Crucible Steel Co. of America, Firth Sterling, Inc., Latrobe Steel Co.

National Steel Corp.—Enamelstrip Div. and Great Lakes Steel Div., Republic Steel Corp., Timken Steel and Tube Div. of Timken Roller Bearing Co., Ulbrich Stainless Steels, Inc., Universal-Cyclops Steel Co., Washington Steel Corp., and Vanadium-Alloys Steel Co.

Joining with the steel companies in making early space reservations are International Nickel Co. and Vanadium Corp. of America, both of which are planning exhibits advancing the broad uses of steel. Already, over 175 display spaces are reserved in the Exposition at this early date.

Seek Classifications

The Committee on Special Classifications, Special Libraries Association, and the Classification Committee, Cataloging and Classification Section, Resources and Technical Services Division, American Library Association, are cooperating in a project to develop and expand a Loan Collection of classification schemes originally established by S.L.A. This Collection covers all fields of science, law, medicine, technology, the social sciences and the humanities.

New libraries or libraries with special collections are constantly asking for classifications, in all areas of knowledge, and it is imperative that the Collection be kept up-to-date through the addition of new schemes or modernized versions of existing schedules. Curators of special collections, special librarians, and individuals who have developed classification schemes for specific types of material or special subjects, are invited to contribute a copy of their work to the Collection. They should be sent to: Dr. Jesse H. Shera, Curator, SLA Loan Collection, School of Library Science, Western Reserve University, Cleveland 6, Ohio.

EMPLOYMENT SERVICE BUREAU

Operated on a no-charge basis for A.S.M. members in good standing. Ads are limited to 50 words and only one insertion of any one ad. Address answers to: Box No., American Society for Metals, Metals Park, Novelty, Ohio, unless otherwise stated.

POSITIONS OPEN

Midwest

SALES: Excellent opportunity for salesman and district manager in Chicago territory with manufacturer of nickel chrome electrical resistance alloys, high-nickel alloys and stainless steels. Send complete resume. Box 5-5.

PLANT METALLURGIST: Experienced in wire mill operations including heat treating and cold heading of wire products. Will manage quality control laboratory and direct heat treating and related technical operations in new integrated processing plant and wire mill. Salary plus benefits. Send details on background and qualifications. Box 5-10.

SALES ENGINEER: Cleveland, Ohio, territory open for experienced sales engineer for nickel chrome electrical resistance wire and other nickel alloy wire, rod and strip. Also stainless steels. Good opportunities for above average income and advanced responsibilities with progressive company. Salary and incentive program. Send complete resume. Box 5-15.

RESEARCH METALLURGIST: M.S. or B.S. with exceptionally strong research experience in physical metallurgy. Knowledge of X-ray diffraction desirable. Research programs involve determination of rolling textures, phase diagrams, recrystallization studies, high-temperature protective coatings and alloy development. Opportunity for collegiate teaching. Salary competitive with industry. Excellent and modern laboratory facilities on campus. Young and congenial staff. Send complete resume to: Special Projects Div., University of Dayton Research Institute, Dayton 9, Ohio.

METALLURGICAL ENGINEER: Aluminum smelter known for its progressive outlook, located in large city, desires graduate of metallurgical school who has specialized in die casting foundry processes and aluminum smelting. In addition to excellent fringe benefits and an outstanding opportunity for the qualified candidate, a high starting salary is offered. Send complete, detailed resume in confidence. Box 5-20.

CERAMIC ENGINEERS: With one to five years' experience in the application of refractories of all types, preferably in the iron and steel industry, to work with an expanding refractory application, control and development organization in a large and extremely diversified iron and steel producing facility. Openings available for graduate ceramic engineers, or engineers with experience in this field who have a working knowledge of refractory applications and control in blast furnaces, various steel producing processes and rolling mills. If you desire a challenging opportunity for professional growth and advancement in this and other fields send complete resume. Box 5-25.

METALLURGICAL ENGINEER: Under 35. Opening in central metallurgical department of corporation with multi-plant operation for manufacturing automotive parts involving stampings, forgings, castings and all types of heat treatment. Ferrous metallographic experience required. Work involves metallurgical analysis of field failures, some practical research and development, customer and vendor contact and eventually material and process specifications. Box 5-30.

PROCESS CONTROL OR RESEARCH METALLURGIST: Engineer with two to five years' practical experience in one or more of the following fields: copper-base alloy melting; wrought products development; welding and fabrication; induction furnace melting of stainless steels, nickel or cobalt-base alloys; other closely allied fields. Prefer a metallurgical engineer but will consider other fields of engineering as well. Excellent opportunity for capable and energetic man. Salary open. Please reply stating your personal data, qualifications, experience, salary expected and availability in first letter. All inquiries will be held in strict confidence. Direct correspondence to: Ampco Metal, Inc., Personnel Dept., Box 2004. Milwaukee 1, Wis.

STEEL SALESMAN: For cold finished bars. Excellent opportunity. College trained, under 35 preferred. Man selected will be trained for mill sales in the Detroit, Mich., area. Replies will be held confidential. Write full particulars, including residence and telephone. Box 5-35.

STEEL RESEARCH METALLURGIST: To conduct research and development projects in alloy steels in modern laboratory. Knowledge of laboratory electric steel melting techniques as applied to steel process studies and alloy development and knowledge of methods of analysis and examination and testing of experimental alloys essential. Five years melting practice closely allied with research and development programs required. Advanced degree, preferably Ph.D., desirable but not necessary. Location: Latrobe, Pa. Write to: G. Y. Taylor, Adminstrative Services, Alco Products, Inc., Schenectady 5, N.Y.

PHYSICAL METALLURGISTS

Experienced Research Metallurgists (Ph.D. preferred) are needed to work on stimulating fundamental and applied programs. Program areas include phase equilibria, diffusion, surface energy effects, deformation and fracture, alloy development, newer metals and many others. Applicants should combine enthusiasm and ambition with personal drive in addition to research experience.

Opportunity exists to work on programs of your own selection. Every encouragement is given to your professional development through publication of papers and related attendance at society meetings and conventions. Outstanding individual ability is appreciated and rewarded in an environment which combines the better features of academic and industrial research.

ARF is a mature, internationally recognized independent research organization with a staff of over 600 engineers and scientists backed up by a like number of technicians and supporting staff. As a member of our professional staff you will receive attractive compensation plus generous benefits among which are tuition-free graduate study, up to four weeks vacation, an opportunity to teach, and a liberal relocation allowance.

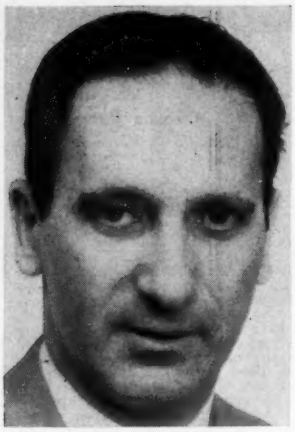
For prompt consideration send a complete resume to:

John F. Collins

ARMOUR RESEARCH FOUNDATION

of Illinois Institute of Technology

10 W. 35th St. Chicago 16, Illinois



BERNARD S. LEMENT HAS WRITTEN FOR YOU . . .

DISTORTION IN TOOL STEELS

A NEW BOOK PUBLISHED BY AMERICAN SOCIETY FOR METALS

Distortion in Tool Steels is a practical, easy-to-read book exploring the size and shape changes in tool steels which occur during and after processing.

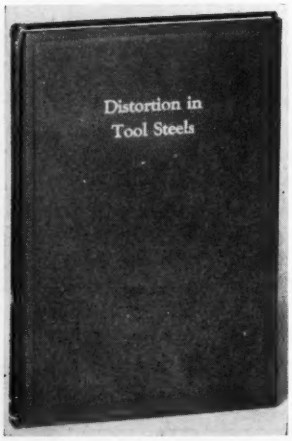
Readers will benefit greatly from the experience of its author. Dr. Lement's background includes both theoretical and practical work in this field and in this book he has sorted the most useful data yet assembled on this expensive problem to industry. His comprehensive knowledge has resulted in this first-of-its-kind book for metals and materials engineers, tool engineers, designers, heat treaters, machinists, mechanical engineers and inspectors.

Dr. Lement places particular emphasis on methods of heat treatment that are necessary for precise dimensional control. The problems encountered in the production of tool steel parts with extreme tolerances (cutting tools, dies, gages, ball bearings, valves, etc.) are treated in detail.

Also, how to prevent significant changes in finish dimensions during storage or under normal service conditions is discussed. How to minimize or eliminate costly finish machining operations by scientific dimensional control is thoroughly explored.

Tables, drawings, charts and graphs highlight the book's eight chapters:

1. CAUSES OF DISTORTION
2. MEASUREMENT OF DIMENSIONAL CHANGES
3. CALCULATION OF SIZE CHANGES
4. CONTROL OF DISTORTION
5. HARDENING
6. COLD TREATING
7. TEMPERING
8. AGING



If you are directly or indirectly related to the manufacture of tool steels or tool steel parts, *Distortion in Tool Steels* is a work of great importance. Dr. Lement writes to the men responsible for tool steel performance. His book represents an opportunity to become fully informed on size and shape changes in tool steels. Order your copy today.

ORDER WITH THIS COUPON

Distortion in Tool Steels—173 P.—8 chapters—illustrated—red cloth cover—6" x 9"—published by American Society for Metals—written by Dr. Bernard S. Lement—$10.00 per copy.

Please send me _____ copy(s) of *Distortion in Tool Steels*

Name_____

Title_____

Company_____

Street_____

City_____ Zone_____ State_____

Enclosed find $_____ Or: Bill me ☐ Bill Company ☐

AMERICAN SOCIETY FOR METALS

Metals Park — Novelty, Ohio

METALLURGIST: For nuclear power plant. To recommend, specify and plan development of materials, fabrication techniques and testing methods for reactors and associated equipment. Gather, analyze and adapt data gained from competitors and government laboratories engaged in research and development, and the manufacture of reactors and associated equipment. B.S. in metallurgical engineering with five years' metallurgical experience required. Nuclear power plant experience helpful. Contact: G. Y. Taylor, Administrative Services, Alco Products, Inc., Schenectady 5, N.Y.

METALLURGICAL ENGINEER: Experienced, to handle production and metal problems in drawing and fabricating ferrous and nonferrous alloys. Box 5-100.

East

HEAT TREAT METALLURGIST: Recent metallurgical graduate for commercial heat treating plant in New England. Excellent opportunity for a practical engineer to advance into supervisory and management positions. Box 5-40.

POSITIONS WANTED

METALLURGICAL TECHNICIAN: Interested in position utilizing experience. Age 27, married. Eight years' experience, including metallography (mostly research work on ferrous and nonferrous metals), complete photographic knowledge including color process, failure investigations, micro and macrohardness testing. Fluent knowledge of French. Will relocate in Canada or U.S. Immigration papers in order. Desires affiliation with progressive manufacturer, private research or university laboratory. Box 5-45.

METALLURGICAL ENGINEER: B.S. degree, age 31, married. Five years' experience in application of materials for high-temperature and corrosion resistant components: fabrication and process development; field trouble shooting and technical counseling. Desires responsible position in customer contact work or sales engineering. Prefers Midwest or West Coast. Box 5-50.

INDUCTION HEAT TREATING TECHNICIAN: Five years' experience in design, development and metallurgical applications of induction heating. Fifteen years' commercial heat treating practice with various companies in categories up to foreman. Age 38, married. Seeks position in New York or New Jersey. Resume on request. Box 5-55.

METALLURGIST: B.S. and M.S. degrees, age 32, married. Seven years' experience. Master's thesis in corrosion research. Four and one-half years experience with tools and

GAS • OIL • ELECTRIC

DIRECT FIRED OR ATMOSPHERE CONTROLLED

Production Heat Treating Equipment

Of any of these types

• BATCH • CONVEYOR • ROTARY
• CAR TYPE • SHAKER HEARTH
• ROLLER TYPE • WALKING BEAM

HOLCROFT & COMPANY

6545 EPWORTH BLVD. DETROIT 10, MICHIGAN
43 YEARS OF ENGINEERING LEADERSHIP

Metallurgists and Engineers

Reactor Materials. Investigation and analysis of mechanical and physical properties of nuclear fuels and materials for high temperature reactors. Development of ferrous and non-ferrous alloys.

Fuel Element Engineering. Complete analysis and design of fuel elements including nuclear, thermal, material, mechanical and cost analyses. Theoretical determination of creep and stress under all operating and fuel handling conditions. Environmental and non-destructive testing.

Fuel Fabrication. Development of equipment and processes for fabrication and assembly of fuel elements. Develop melting, alloying, forming, welding and joining processes for new alloys and ceramic materials.

Corrosion Research. Corrosion and heat transfer research on new materials and advanced liquid metals at elevated temperatures.

Hot Cells. Design and development of hot cell equipment and processes. Remote handling of radioactive materials, especially metallurgical and physical testing.

Irradiation Experimentation. Design and conduct irradiation experiments on reactor fuels over wide range of radiation and temperature conditions, including simulation of conditions expected in full scale power reactors. Development of equipment and techniques for post-irradiation testing and evaluation of these experiments.

For specific details write:
Mr. D. E. Newton, Personnel Office, Atomics International, 8900 DeSoto Avenue, Canoga Park, California.

ATOMICS INTERNATIONAL
A DIVISION OF NORTH AMERICAN AVIATION, INC.

ASM offers guide for quick and easy indexing of everything metallurgical

ASM-SLA METALLURGICAL LITERATURE CLASSIFICATION

INTERNATIONAL (SECOND) EDITION
80 PAGES—8½x11—SPIRAL BOUND—HARD COVERS

- The result of two years' work by an outstanding committee of the American Society for Metals, working closely with European technical groups, this Classification and descriptive text is greatly expanded over the first edition published in 1950.

- Here is an outline of the entire metallurgical area that provides an effective guide to the filing, indexing, arrangement, collection and use of all metallurgical literature and data.

- Metallurgists — engineers — researchers — librarians — all these and others can make highly effective use of this new and modern indexing system. Adaptable for use with hand-sorted punched card systems or more conventional means of literature control.

- Looseleaf "Worksheets" are also available to provide expanded coverage of minor fields, to add new subjects or to develop desired sidelines—essential to the user who wishes the utmost detail.

- Specially designed punched cards for use with the system and punched card filing equipment can be ordered from Lee F. Kollie Associates, Inc., 236 North Clark St., Chicago 1, Ill. (price sheet on request).

USE COUPON BELOW TO ORDER COPIES OF CLASSIFICATION BOOK AND WORKSHEETS.

American Society for Metals
7301 Euclid Ave., Cleveland 3, Ohio

Please send me:

☐ ASM-SLA Metallurgical Literature Classification $3.00

☐ Set of Worksheets $5.00
Punched for standard three-ring binder

Name ..... Title .....

Firm ..... Street Address .....

City ..... Zone ..... State .....

Check enclosed ☐ Bill me ☐ Bill my company ☐

toolsteels, including all phases of heat treatment, metallography, testing, customer complaints, photography, report and specification writing. Box 5-60.

METALLURGIST: B.Met.Eng. degree, family. Eight years' diversified experience in research department of large corporation. Specialties include high-temperature alloys, investment casting, powder metallurgy, high-temperature brazing and protective coatings. Supervisory experience and technical report writing. Desires position in applied research. Box 5-65.

CORROSION CHEMIST: Widely experienced. Chemical engineering graduate and limited metallurgical background. Forty plus. Citizen. Write: P.O. Box 6628, Philadelphia 49, Pa.

METALLURGICAL ENGINEER: B.S. degree, age 28, married, family. Experience in quality control metallurgical laboratory. Duties include failure analysis, specifications, process control, metallography, technical reports, physical and nondestructive testing and some vendor contacts. East preferred but not required. Desires job with challenge and opportunity. Box 5-70.

METALLURGICAL ENGINEER: B.S. degree, ten years' varied experience in testing, engineering and manufacturing problems. Desires responsible position with progressive organization in western state. Can relocate immediately. Resume on request. Box 5-75.

METALLURGIST: Recently returned from Middle East, desires foreign employment. Nineteen years' diversified experience in heat treatment of ferrous and nonferrous metals; charge of quality control laboratories in manufacturing; metallurgical consultant; engineer in charge of materials laboratory, inspection division; ordnance technical advisor, problems in repair, maintenance and manufacturing of all types of ordnance equipment. Resume on request. Box 5-80.

DIE CASTING ENGINEER: With 20 years' experience, available after June 1, 1960. Ten years in die design, last ten as superintendent of complete operation from estimate through production. Sales, engineering or partnership interest. Box 5-85.

METALLURGIST ENGINEER: B.S. degree, age 28, married, family. Six years of varied ferrous metallurgical experience, with emphasis on engineering specifications, machining problems, production heat treating, metallography, physical testing and failure analysis. Supervisory experience. Capable technical report writer. Desires opportunity for further professional growth in either writing, management or technical areas. Box 5-90.

COLLEGE PROFESSOR: Specialist in physical metallurgy, with working knowledge of German, French and Russian, wishes summer assignment in Europe. Box 5-95.

SENIOR PROJECT ENGINEER: Metallurgist, M.S. degree, age 38. Fourteen years experience in production, development, research and new product development. Wide experience in many materials, processes and application. Desires challenging position in growth industry, preferably nondefense. Box 5-105.

Arc Melting Metallurgist

To supervise Arc Melting Laboratory and Pilot Plant aimed at developing refractory metal products. Three to seven years' arc melting experience desired. Send résumé and salary requirements to: S. Abkowitz, Manager, Refractory Metals Products Development, or to H. S. Rummell, Personnel Manager, Metals Division, Kelsey-Hayes Company, New Hartford, New York.

MATERIALS ENGINEER

Needed to coordinate materials programming for Mechanical Engineering Division in support of nuclear explosives design effort. Position involves:

- **Consulting with Process Development and Project Mechanical Engineers to establish development programs.**
- **Advising experimental and theoretical physicists during preliminary design studies.**
- **Performing technical liaison with Laboratory and sub-contractor materials groups.**

Degree plus 5 years experience required. Applicant must possess a diversified knowledge of metals, plastics, and ceramics, and the ability to assess new techniques and results of investigations involving unusual materials.

U. S. CITIZENSHIP REQUIRED

Please submit confidential resume to Gilbert B. Rankin, Personnel Department.

LAWRENCE RADIATION LABORATORY

(Livermore Site)

P.O. Box 808 B

LIVERMORE, CALIFORNIA

(One hour from downtown San Francisco)

J&L STEEL

RESEARCH METALLURGISTS

Continuing growth of the J&L research and development program has created a number of openings for professional personnel, holding Ph.D., M.S., or B.S. degrees in metallurgy or a related scientific field. Projects underway or in prospect cover a diversity of subjects in physical and process metallurgy, all of course, related to the production of carbon and stainless steels, and all company supported. Because of this diversity, it is almost always possible to accommodate individual interests.

The J&L Research Division is housed in the modern, air-conditioned, fully-equipped Graham Laboratory in suburban Pittsburgh. Attractive residential areas are close by. And progressive Pittsburgh offers many advantages, including full graduate programs at the University of Pittsburgh and Carnegie Institute of Technology for the man who wants to continue his professional education.

If you have these interests, we would like to hear from you, and will respect your confidence. Write.

J. A. Hill
Research and Development Department

JONES & LAUGHLIN STEEL CORPORATION

#3 Gateway Center
Pittsburgh 30, Pennsylvania

METALLURGIST
PHYSICIST
or
PHYSICAL CHEMIST

Develop and apply new and improved materials for sensors for diverse line of instrumentation products.

Examples of current investigations:

Photoconductive and photovoltaic materials for photometric measurements.

Thermoelectric and resistance materials for high temperature measurements.

Position offers opportunity for professional growth by making significant contributions to products vital to the Company's long range objectives in the rapidly growing field of industrial automation.

Plant location makes available the educational, cultural, recreational, and suburban living advantages of the Boston area.

Requirements: BS or MS degree in any one of the related disciplines and a record of accomplishment indicating creativity and a capacity to develop ideas into useful products.

Write, in confidence, to
Mr. H. E. Crabtree, Manager,
Engineering Administration

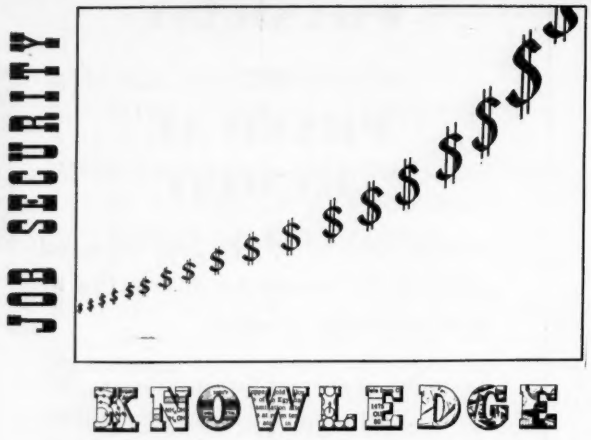
INSTRUMENT DEPARTMENT

GENERAL ELECTRIC

48 Federal Street, West Lynn 3, Mass.

Progress Is Our Most Important Product

Metallurgists, Metals Engineers, and Technicians!



YOUR *JOB SECURITY* and *INCOME* depend on YOU— and what you know

The ASM Metals Engineering Institute, home study school of the metals industry, can help you.

NOT ONLY CAN INCREASED KNOWLEDGE OF METALS MAKE YOUR JOB MORE SECURE, IT CAN ALSO LEAD TO ADVANCEMENT—AS IN THE CASE OF MR. O.P.M., WHO WROTE TO MEI: "THANKS TO YOUR FINE COURSE, I HAVE TAKEN OVER THE JOB OF MY PAST SUPERVISOR . . ."

MEI courses are available in a variety of general and specific subjects. We will mail you our 32-page catalog when you send in the coupon below.

Learning the MEI way is made as pleasant and easy as possible. We substitute everyday language for textbook language, eliminate unnecessary detail, and try to give you a maximum of knowledge with a minimum of effort on your part.

If you have *ability*, the *ambition*, the *drive*, you'll find MEI a convenient stepping stone to a *more profitable and secure future*.

Remember, in today's rapidly changing world, NOT TO MOVE FORWARD IS TO FALL BEHIND!

Sincerely yours,

Anton deS. Brasunas

Anton deS. Brasunas, Director
Metals Engineering Institute

ARE YOU WILLING TO GAMBLE 4¢ ON YOUR FUTURE? Mail coupon today!

Metals Engineering Institute
7301 Euclid Avenue, Dept. R40
Cleveland 3, Ohio

Send me detailed information concerning MEI courses. This does not obligate me in any way.

Name (please print)_____

Mailing address_____

City_____ Zone_____ State_____

Present position_____ Age_____

Employer_____

Metallurgists

Battelle has openings for several qualified metallurgists for research in the areas of:

- Physical Metallurgy
- Alloy Development
- Mechanical Working of Metals
- Process Development

The need is for young men with 2 to 3 years of industrial research experience.

L. G. HILL
Personnel Department
Battelle Memorial Institute
505 King Avenue Columbus 1, Ohio

METALLURGIST: B.S. in chemical engineering, with 19 years experience in the following fields: aeronautical, investment casting, ferrous and nonferrous, and ordnance. Developed new bath for anodizing aluminum alloys, also for hard chrome plating. Patent pending on new investment for precision casting, one coat and shell investment by CO_2 type process. Box 5-110.

SUPERVISING METALLURGIST: Internationally known, with background of over 15 years with large contract research laboratory, will leave for a position as research director, technical director or comparable position. Salary $20,000-30,000. Box 5-115.

METALLURGIST-TEST ENGINEER: Registered mechanical engineer, age 45, married, no children. Experience includes ten years in aircraft industry, four years university teaching. Prefers western U.S. or overseas. Resume on request. Box 5-120.

SUPERVISOR OF ANALYTICAL CHEMICAL LABORATORY: Age 45, B. Met. Eng., with 17 years in ferrous and nonferrous analysis, the last six as assistant chief chemist. Capable of assuming complete charge as to methods, equipment and personnel of laboratory. Minimum salary $700 a month. Box 5-125.

ASSISTANT PROFESSOR: To teach metallurgical thermodynamics and kinetics. The qualified applicant will have a new or recent Ph.D. in metallurgy but may have undergraduate training in another field. Teaching duties commence September 1960. Apply to: Head, Dept. of Metallurgy, Montana School of Mines, Butte, Mont.

ATOMIC PERSONNEL, INC.
WRITE FOR APPLICATION OR SEND RESUME
•
CONFIDENTIAL HANDLING
A NATIONAL EMPLOYMENT AGENCY for the NUCLEAR FIELD
•
NO CHARGE TO INDIVIDUALS
Suite 1207-J, 1518 Walnut St., Phil. 2, Pa.

METALLURGIST

PHYSICAL METALLURGIST

CRUCIBLE STEEL CO.
APPLIED RESEARCH LAB
SYRACUSE, N.Y.

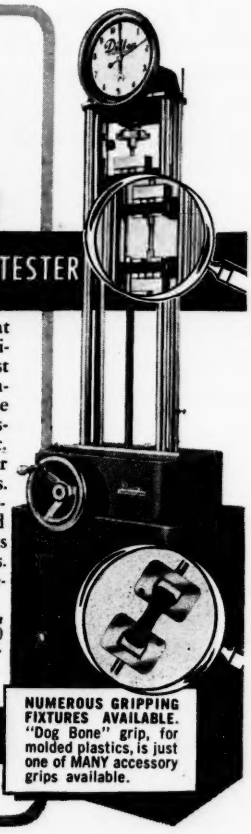
EDUCATION: M.S. in Metallurgy or B.S. with 2 years in field of super alloys. 2 to 4 years in metalography, heat treatment and mechanical testing. Some experience in field of super alloys is desirable. Challenging work in physical metallurgy of vacuum melted steels in super alloys. Must be capable of conducting experiments on alloy developments, with minimum of supervision, writing clear and concise reports and supervising mechanical testing activities. Excellent employe benefit program and salary.

Send replies to: MR. J. E. HARRIS

CRUCIBLE
STEEL CO. OF AMERICA
P. O. BOX 88 PITTSBURGH 30, PA.

Your Best Bet
and at a low, low price, too!

Dillon UNIVERSAL TESTER



Designed for top accuracy at low cost, the DILLON Universal Tester is your wisest investment. Operates in tensile, compression, transverse or shear. Checks metal, plastics, wire, rubber, springs, etc. 7 interchangeable gauges. For materials up to 125,000 lbs. PSI tensile. Hand wheel operation or motorized. Equipped with max. indicator. Meets most all ASTM & Fed. specs. Handles round, flat or special shapes.

For low strength materials between 0 & 300 lbs. Model M (not shown) is available. Accurate to ½ of 1%. Has 5 scales.

Write TODAY for brochures and LOW price schedule.

NUMEROUS GRIPPING FIXTURES AVAILABLE. "Dog Bone" grip, for molded plastics, is just one of MANY accessory grips available.

W.C. Dillon & CO., INC.
14628 KESWICK STREET
VAN NUYS 26, CALIF. LM31

METALLURGIST

ADVANCE DEVELOPMENT OF SEMICONDUCTOR DEVICES

PHD or MS or equivalent with background in Physical Metallurgy or solid state to assist in development of micro metallurgical techniques under protective atmospheres, vacuum deposition of high purity metals, and the study of recrystallization of rare metals during alloying and welding operations on subminiature scale.

WRITE: M. D. Chilcote, Div. MR-5
Semiconductor Products Dept.
Electronics Park, Syracuse, New York

GENERAL ELECTRIC

the most DYNAMIC ATTRACTION

a show ever had!

at the 1960 PHILADELPHIA

42nd NATIONAL METAL CONGRESS & EXPOSITION

Philadelphia Trade and Convention Center • Oct. 17-21, 1960

Steel, the sinew that binds the strength of America, will serve as a magnetic attraction to call attention to **every** area of metals technology, ferrous and nonferrous, at the most metallic of all Metal Shows — the 1960 Philadelphia Metal Show, now blue-printed and ready to grow into its full dimensions. This new emphasis on the essential metals of industry reflects a growing specialization . . . a **focusing** of attention . . . to yield a greater benefit. In the evolution of the Metal Show, the time for such refinement has come. Now it is possible to achieve a concentration on **materials** that is unsurpassed anywhere for an intensive person-to-person interchange of information. The STEEL ARENA is the threshold to a whole new world of metals within the exhibits and technical sessions. The pre-eminence of a Metal Show of these dimensions is worth your closest consideration as an exhibitor — you are invited to share its benefit in any of the eleven areas of metals listed.

EXHIBITORS FROM ELEVEN METALS AREAS

1. Ferrous Metal Producers and Distributors
2. Nonferrous Metal Producers and Distributors
3. Related Engineering Materials
4. Nuclear Materials and Equipment
5. Tool Materials, Cutting-Off and Forming Equipment
6. Industrial Heating Equipment and Supplies
7. Cleaning and Finishing Equipment and Supplies
8. Welding and Joining Equipment and Supplies
9. Testing, Inspection and Control Equipment and Supplies
10. Production and Casting Equipment and Supplies
11. Parts, Forms and Shapes for Design and Applications

Exhibitors at the Philadelphia Metal Show will gather their customers and prospects from the broad metalworking industry, including automotive, aircraft, appliance, ordnance, farm machinery, electrical machinery, instruments, and miscellaneous metalworking manufacturers . . . creating a thriving, effective, profitable marketplace. If your potential for sales lies in any of these areas, the Metal Show should take priority in your sales plan for maximum impact in the Soaring Sixties.

Floor Plan Folders are now available — for complete information, consult the ASM representative nearest to you, or write direct.

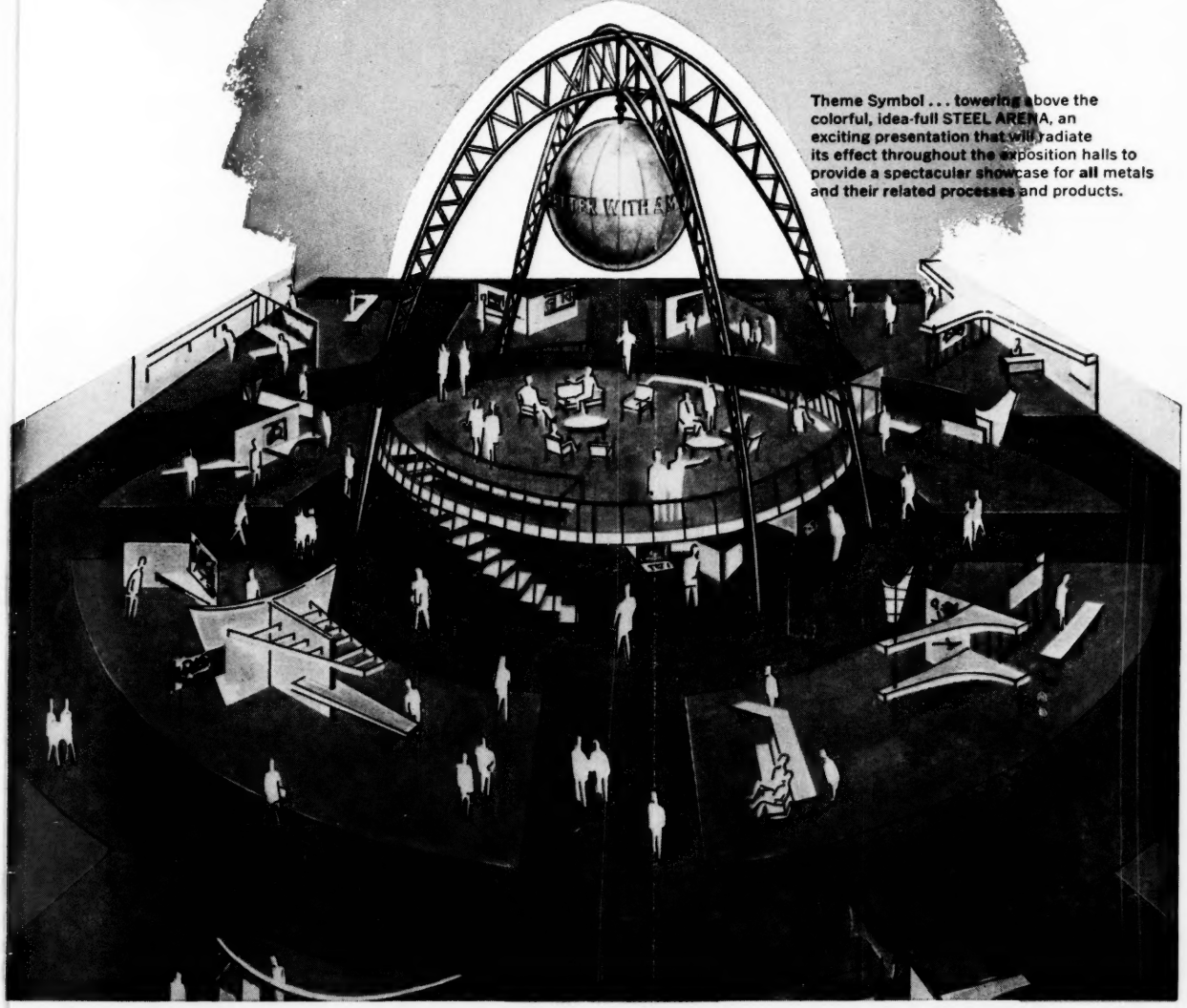
NEW YORK — OXford 7-2667
CLEVELAND — JOrdan 4-2271 (Novelty, Ohio)
CHICAGO — WAbash 2-7822

MAKE PLANS NOW TO EXHIBIT AT THIS GREATEST OF ALL METAL SHOWS!

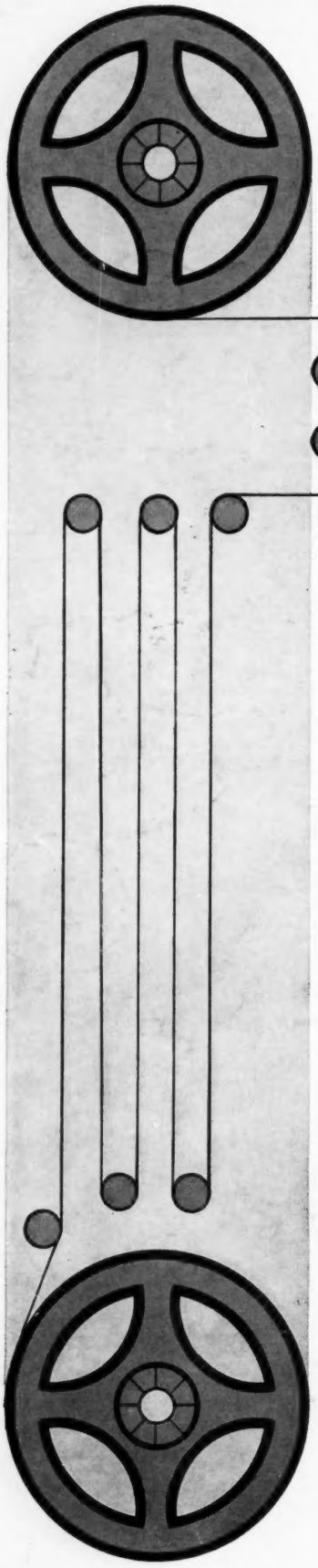
AMERICAN SOCIETY FOR METALS
Metals Park • Novelty, Ohio

. . . a benefit to every exhibitor

METAL SHOW



Theme Symbol . . . towering above the colorful, idea-full STEEL ARENA, an exciting presentation that will radiate its effect throughout the exposition halls to provide a spectacular showcase for all metals and their related processes and products.



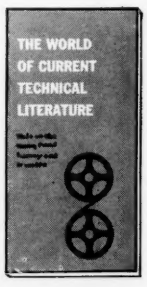
EVERY TWO WEEKS THIS TAPE CAN DELIVER THE WORLD OF CURRENT TECHNICAL LITERATURE TO YOUR DESK

Now you can say good-bye to page-by-page searching of hundreds of magazines for the technical information you need . . . because the American Society for Metals is coding, on electronic tape, every current metals article from over 600 of the world's leading magazines . . . plus patents, government reports, books, everything published. This will be a continuing process. The tape will contain, in code, every article you will read and the many articles you won't read because you will never see them.

You can subscribe to the use of this tape through the Information Searching of ASM's Documentation Service. As a subscriber, you tell ASM the subject in which you are interested. Then, every two weeks, ASM sends you digests of only the current published information which touched on that interest. Your requested subject can be as broad as "vacuum melting and pouring" or as definitive as "properties of stainless steel for temperatures down to —423° F." Whatever your interest, ASM sets its electronic searching selector and from the tape comes your tailor-made digests. From these digests you may then order photocopies of the articles you want for your library or for immediate reference.

ASM's Information Searching is a most important advance in modern research tools. It is a major breakthrough for any firm which looks to technology for the solution to metals problems. For firms of any size, it can inexpensively provide what until now was impossible; a complete and continuing world library of specific information without the turning of a page.

A descriptive booklet will answer any questions you may have. For your copy—and for information on any specific searches you have in mind—fill in and return this coupon today.



Name_____

Title_____

Company_____

Street_____

City_____ Zone____ State_____

Subjects of interest:_____

_____

_____

AMERICAN SOCIETY FOR METALS

DOCUMENTATION SERVICE • METALS PARK • NOVELTY, OHIO